# Effects of a Drums Alive Kids Beats Intervention on the physical performance and behavior of children with developmental delays in the areas of motor development, concentration and impulse control

## Effects of a Drums Alive Intervention in Children with developmental delays and intellectual disabilities

Carrie Ekins[1], Jacqueline Wright[4], Marianne Liebich[3], Peter R. Wright[5], Henry Schulz[2,] Dean Owens[6]

[1] Drums Alive ® UG, 86500 Kutzenhausen
[2] Chair of Sports Medicine, Technische Universität Chemnitz, Thüringer Weg 11, 09126 Chemnitz, Germany
[3] Katholischer Kindergarten St. Theresia, Bochum, Germany
[4] ??? Doctorate Candidate Chemnitz, University, Germany
[5] Department of Sport and Health Sciences, Oxford Brookes University, Oxford, United Kingdom
[6] Professor, Embry-Riddle Aeronautical University, JBMDL, New Jersey, USA

The aim of this study was to examine the effects of a Drums Alive Kids Beats Intervention on the physical performance and behaviour of children with developmental delays in the areas of motor development, concentration and impulse control (aged 4.9-6.1 years) in comparison to children with a normal development (aged 4.1-6.1 years). All children were recruited from a pre-school in Bochum/Germany. Table 2 shows the descriptive characteristics of all subjects (Intervention group (IG); Control group (CG)). Written informed consent was received of the legal guardians of all subjects prior to their participation in the study.

### 2.1.2 Behaviour and motor skills outcome measures

The test profile (see table 3) consisted of the Duesseldorf Motoric Test (reference), which included 18 exercises, measurement of the anthropometric data as well as the documentation of different behaviour patterns. The latter has been documented during the intervention at each Drums Alive session. The motoric test as well as the anthropometric data has been conducted before and after the intervention phase.
Composition of project groups

16 Kindergarten children (Age 4,9-6,7 years), two children = Integrated Classroom, Weaknesses in: Motor skill, concentration and impulsive behavior control.
10 children elementary school ages (4,9-6,7 years) with o. g. Handycaps
10 Kindergarten children (Ages 4,1-6,1 years) (Control group)

**Methodology:**
Pre and Post application of the intervention:
Motor skills test (The Heinrich Heine Universität Düsseldorf) HKI – Heiderberger Kompentency Inventory
VFE – Verhaltensbogen Entwicklungsstörungen

Weight, Height
Documentation of behavior
Integration of Drum Alive into the kindergarten and school

**Results of Behavior**
The documentation of behaviour (compliance with rules, better concentration and persistence, more creativity) showed individually better results in the intervention group compared to the control group.

**Results of the Motor Skills Test:**
The results of the Duesseldorf Motoric Test shown in motoric units. Both intervention groups showed significant improvements in their overall motoric skills compared to the control group. With an increase of 33%, the children of the nursery intervention group benefited the most from the Drums Alive® intervention.

The motor activity test revealed that nearly all children that participated in the study improved their motor skills.

- Jumping power
- Coordination
- Reaction

The testimony of the children and the behavioral observations make it advisable to carry out more extensive research in this area.

The fact that the children were able to be reached emotional, this developing a strong joy (while) learning, (leads us to believe) the Drums Alive program may be more effective in achieving positive results than other programs.

**Key Words**: ….. *Polyrhythmic, Multi-modular, Multi-discipline, Enriched environment, Sportive Drumming, Diverse Abilities (a.k.a. special needs)* mindfulness; meditation; mental health; physical health; quality of life; stress reduction Drums Alive, Drumtastic, Drumming, Fine and Gross Motor Skills, Coordination, Balance, Endurance, Stress, Aggression, Concentration, Impulse Control, Social Relationships Physical aptitude, coordination, hand-eye co-ordination, sensor motor integration, developmental changes personal-social interactions, keeping a beat

**Unique skills in creating a positive rehabilitation experience are all key ingredients to the success of this program**

# Abstract IDEAS

The purpose of this study was to examine the impact of an assessment protocol utilizing a …..
Method: …..
Results: All children were …
Conclusion: the findings indicated that …..

The purpose of this study was to examine …. In children with….is limited. This study assessed whether children with….. show….. and examined the relationship between…. ___children diagnosed with …. Were assessed using the … and the ….. The …. Measures children´s ….. and the …. Measures children´s…… Overall, the samples´scores on the …. Indicated …. on the ….showed…. as compared to … Futhermore, the samplesß scores for …. Were positively correlated with their motor performance. The results suggest that …. and …. May be related to their delayed sensory processing to visual, auditory, tactile, and movement stimuli, and that this hypothesis needs to be tested in future research.

This study inestigated the effect of instructional versus free play on…. Participants were…. Two types of activities (Gymnasium and pool) were alternatively presented to particpants to identify trends in ….between … and … The results demonstrated that compared to… Instruction ….

The study aimed to investigate the impact of an…. Week structured physical activity program on selected psychosocial behaviors of children with intellectural disabilities (ID) and to estimate whether generalization occurred. Thirty children (__boys and __girls) wild mild ID took part in the study. The ___results showed a significant difference between the training group and the control group in :::: scores; (list results) The correlation analysis showed a :::::: Hence, generalization appeared to have occurred.

# Effect of Physical Activity on the Stereotypic Behaviors of Children With Autism Spectrum Disorder

Ting Liu,[1,*] Anne T. Fedak,[1] and Michelle Hamilton[1]

[1]Department of Health and Human Performance, Texas State University, San Marcos, USA

**Corresponding author*: Ting Liu, Department of Health and Human Performance, Texas State University, P. O. Box: TX78666, San Marcos, USA. Tel: +512-2458259, Fax: +512-2458678, E-mail: tingliu@txstate.edu
**Received** 2015 March 29**; Revised** 2015 May 29**; Accepted** 2015 June 2.

**Background:** Physical activity is now widely accepted as a measure to reduce stereotypic behaviors in children with Autism Spectrum Disorder (ASD). However, several issues exist

concerning the effects of physical activity on stereotypic behaviors, such as inconsistency because it classified the intensity of physical activity using heart rate, monitored the children´s behavior over a span of 4 hours after physical activity and documented how long stereotypic behavior reduction lasted. The regimented exercise routine was also enriched with fun and motivational activities.

**Objectives:** The purse of this study was to examine the effects of physical activity on stereotypical behaviors of children with ASD.

Patients and Methods: The present study was comprised of 23 children aged from 5 – 11 years, who particpanted in 15 min. of moderate to vigorous physical activity (MVPA). Physical activity was indetified as moderate or vigouoous based on the child´s heart rate. Particpants were observed for a period of 2 hours before and after 15 minutes engagement in MVPA and their behaviors were then classified as either post percentage scores to analyze the physical activity effects on children´s stertypic behaviors.

**Results.** A significant reduction in stereotypic behaviors of children with ASD was observed for 2 hours, following 15 min. of MVPA.

**Conclusions:** This information has implications for reserachres and practitioners who consider MVPA particpantion when designing behavior-changing interventions for children ASD.

# Introduction….

## RESEARCH IN CHILDREN SUMMARY

### Effects of a Drums Alive Intervention in Children with developmental delays and intellectual disabilities

Jacqueline Böhr1, Peter Wright1, Henry Schulz1
1Chair of Sports Medicine, Chemnitz University of Technology

### Introduction

In Germany, there are 7.5 Million people with handicaps. 11% thereof are suffering from intellectual disabilities (Statistisches Bundesamt, 2013).

Motor disorders, mainly in coordination, such as hand-eye-coordination are one of the integral parts of intellectual disabilities (Lehmkuhle, 2007; Van der Schoot, 1990). Therefore, exercise therapy, with coordinative elements seems to be an important intervention for these patients.

In this context drumming, dancing and music are important forms of communication since mankind evolved. It seems that drumming has great acceptance, not only cross-cultural, but also across social borders and different age groups as well and therefore could be used as a medium to introduce a wider population to exercise. That´s why we have been investigating conventional drumming and sportive drumming exercises since 2009. Drums Alive as an sportive drumming intervention uses big gymnastic balls and usual Drum Sticks to move to the music, with aerobic and dance elements as well as strength training and is of course

highly coordinative. It can be very emotional and regarding the investigated populations it has great potential as patients can literally drum out their emotions and aggressions. Especially regarding neurological diseases, the release of neurotransmitter through physical exercise and also through drumming and dancing are a very important key factors and already proven.
The main obstacle is to motivate patients to exercise. An important key factor for motivation is fun and a good feeling while exercising rather than just feeling bored and exhausted.
Therefore, a Drumming Exercise Intervention that combines endurance, strength training and highly coordinative and emotional elements could be a worthy intervention for children with developmental delays and intellectual disabilities.

## Methods

15 children with mental disabilities at the age of 13.9±2.7 years were allocated into two intervention groups and either attended the conventional school sports (SG) only or participated in two additional Drumming Exercise Intervention classes (DG) twice a week. Before and after the seven-week lasting intervention the children´s motor performance was tested through the German Motor Test by Bös (DMT). Furthermore, children´s behaviour was determined through the *Heidelberg Compentency Inventory (HCI)* and a questionnaire for developmental disorders (*Behaviour Questionnaire for developmental disorders-VFE*) as well as the monitoring of children´s behaviour through the teachers (DBC).

## Results

Results showed significant improvement of the DG in motor performance compared to the SG. Regarding the children´s behavior, the DG also showed obvious, but not significant improvements compared to the SG.

The documentation of behaviour (compliance with rules, better concentration and persistence, more creativity) showed individually better results in the intervention group compared to the control group.

## Conclusion

All children of the intervention group showed partly significant improvements in different motor areas. The positive statements of the children and the results of the behaviour monitoring show the potential of Drums Alive as an additional therapeutic approach. The children have been caught emotionally and developed high pleasure in learning which makes DRUMS ALIVE potentially more effective than other interventions.
A final comparing evaluation with other exercise interventions based on this pilot study, is not possible, but the potential of an age specific DRUMS ALIVE Intervention should be further investigated.

### Goals

- Fun and enjoyment of the project
- Improvement of Fine and Gross Motor skills
- Improvement of coordination, balance and endurance
- Stress and Aggression release
- Improvement in concentration and impulse control

## Introduction Ideas THAT WERE USED FOR DRUMS ALIVE

Children all over the word more frequently show developmental delays and/or disorders in different areas that impacts the children´s social activities, self-confidence and self-development. To prevent these limitations, promotion at an early stage is needed. In this context the use of different interventions that include a connection of music- and exercise therapy seems to be especially interesting. Drumming could be a promising approach, as humans are drumming since mankind evolved und percussion has always been a significant part within different cultures (FIGL, 2003). It can therefore be assumed that there would be a high compliance for interventions including drumming, especially in children.
Hence this study examined the effects of a DRUMS ALIVE® Intervention, including aspects of music therapy as well as exercise in children with developmental delays (behavior, motor performance, speech) comparing to a control group at the same age.

## OTHER

Research has shown that drumming exercise and classified as an aerobic and sometimes anaerobic activity[1]. Physical Exercise vital for overall health and wellness, it has also shown to have a positive influences on concentration, memory and classroom behavior[2]. as well as reducing self-stimulators and emotional behaviors in children. [3]

1. British Association of Sport and Exercise Sciences (BASES) Annual Conference, September 2008, Brunel University, West London Physiological demands of rock drumming: a case study Authors: Marcus Smith, Clem Burke: University of Chichester, School of Sport Exercise & Health Sciences, College Lane, Chichester, West Sussex, P019 6PE, UK. Email: m.smith@chi.ac.uk, Steve Draper and Chris Potter: University of Gloucestershire, Faculty of Sport, Health and Social Care, Oxstalls Campus, Oxstalls Lane, Longlevens, Gloucester, GL2 9HW, UK.

2. Physical education, school physical activity, school sports and academic performance François Trudeau†Email author and Roy J Shephard††Contributed equally International Journal of Behavioral Nutrition and Physical Activity20085:10 DOI: 10.1186/1479-5868-5-10© Trudeau and Shephard; licensee BioMed Central Ltd. 2008Received: 04 September 2007Accepted: 25 February 2008 Published: 25 February 2008 https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-10

3. Lang et al., 2010; Loy, 2000; Prupas & Reid, 2001; Valenti, Cerbo, Mased, de Caris, & Sorge, 2010; Yilmaz, Yanardag, Birkan, & Bumin, 2004).

## *Ideas From Chemnitz Master Student (Mario)*

Children in Germany show more and more frequently developmental disorders and/or -delays with negative effects on social activities, self-esteem as well as personal development. To prevent these and other negative effects, specific support is sensible.
In this context a comparison between different interventions, combining aspects of music- and exercise therapy, is of particular interest. Especially the combination of drumming and exercise seems to be promising as mankind traceable has been drumming since the Late Neolithic. In the course of human history drumming has become extremely important in all human cultures (FIGL, 2003). Hence a high *compliance* of the children is expected.

This study examined the effects of a DRUMS ALIVE® Intervention, which combines exercise with aspects of music therapy and especially drumming in children with developmental deficits (behaviour, motor skills, speech) compared to a control group of equal age.

**Or…..**

## Dr. Peter Wright – University of Chemnitz, Germany

**CHANGES OF PHYSIOLOGICAL PARAMETERS IN A SPORTIVE DRUMS ALIVE DRUMMING ACTIVITY AND ITS EFFECTS ON CONCENTRATION AND AWARENESS PERFORMANCE**

Drumming and dancing have been the simplest form of communication since mankind evolved. Even today drumming is still commonly practiced, especially by people in Africa and Asia. It is often the centre of ritual ceremonies and community festivals. The Max-Planck Institute and the University of Manchester for example investigated the acoustic communication forms of Makaka monkeys and found that the drumming with unspecific materials isn´t just a side effect of random actions, but a manifest part of their communication and expression repertoire (Remedios R., Logothetis N. and Kayse C.c 2009).

Drumming therefore appears to be a universal language – also described by the science of intercultural communication as an *anthropological constant*. Hence, all forms of drumming offer great potential as a universal intervention method. Especially if combined with music and exercise or as a sportive activity in order to generate positive effects. It seems that drumming has great acceptance, not only cross-cultural, but also across social borders and different age groups as well and therefore could be used as a medium to introduce a wider population to exercise. However, looking at the existing scientific literature there doesn´t seem to be any evidence based sport/fitness/exercise interventions using drumming as a key element.

This presentation discusses the interim results of a study that investigated a fitness trend that uses elements of drumming and aerobics called Drums Alive®. The focus of the analysis lies on the behavior of physiological parameters during this intervention in adults of different ages. This should produce information on the typical work intensity of this exercise. Furthermore, the effects on acute concentration and awareness performance after a session of Drums Alive® in students were investigated. The here presented study is part of a bigger project "THE DRUM BEAT"- Chemnitz Drumming Project", which evaluates the possibilities of using this type of drumming exercise in various areas of fitness, education and therapy.

https://www.researchgate.net/publication/46255909_A_Physical_Activity_Program_Improves_Behavior_and_Cognitive_Functions_in_Children_With_ADHD

## Or…..from Univ. of Texas

# Dyadic Drumming

Another type of drumming is dyadic drumming which involves the biological concept of rhythmic entrainment, whereby two rhythmic processes interact with each other in such a way that they adjust towards and eventually 'lock in' to a common phase and/or periodicity (Trost et al., 2014). Another key aspect of dyadic drumming is the addition of "reciprocity" to rhythmic entrainment that focuses on socially coordinated behavior between two individuals. Dyadic drumming promotes interpersonal action synchronization (IAS) whereby two partners intentionally adapt their own timing of social behavior to the timing of others' actions. This type of physical and social synchronization is necessary to promote success in one's social life as individuals need to synchronize their actions in a wide range of situations and with different partners (Kleinspehn-Ammerlahn et al., 2011), especially if the rhythm is produced with "strong beat," "high groove" music that a person is emotionally connected to. A link can be built between emotions and proprioceptive feedback (Trost, et al., 2014). Guzic et al. (2011) reported that dyadic drumming with a college partner resulted a positively impact on children with ASD's ability to concentrate and attend to task.
Trost, W., Frühholz, S., Schön, D., Labbé, C., Pichon, S., Grandjean, D., & Vuilleumier, P. (2014). Getting the beat: Entrainment of brain activity by musical rhythm and pleasantness. *NeuroImage,* 103, 55–64.

Aldridge (1989) has emphasized the importance of rhythmic interaction for the development of language and socialization in the infant
David Aldridge, PhD, Dr. Ref. Med. Dagmar Gustorff and Dr. Ref: Med: Lutz Neugebauer, *A preliminary Study of Creative Music Therapy in the Tretment of children with developmental delay*.

David Aldridge is Professor for Clinical Research Methods at the University of Witten Herdecke, Germany.
Dagmar Gustorff and Lutz Neugebauer are Co-Directors of the Institute for Music Therapy at the University of Witten Herdecke.

Language development is one of the most significant processes of early childhood development. Children with delayed speech development are more at risk of acquiring other cognitive, social-emotional, and school-related problems. Music therapy appears to facilitate speech development in children, even with a short period of time.
Aldridge D, Gustorff D, Neugebauer L: A pilot study of music therapy in the treatment of children with developmental delay. Complementary Therapies in Medicine 1995, 3:197-205. http://link.springer.com/article/10.1186/1472-6882-10-39

There are three main processes assumed to be necessary for the performance of motor skills: kinesthesis, muscle control and timing (Laszlo & Sainsbury, 1993). Kinesthesis is the sense that conveys information about the position and movement of the body and

limbs. This sixth sense, referred to by Sacks as “proprioception,” is a sense we have in our bodies and is that continuous but unconscious sensory flow from the movable parts of our body (muscles, tendon, joints), by which their position and tone
and motion is continually monitored and adjusted, but in a way which is hidden from us because it is automatic and unconscious. (Sacks, 1986, p. 42)

Early interventions are essential to aid social and emotional development in children with ID (Block, 2000; Hellison & Templin, 1991; Krebs, 2005; Wright & Sugden, 1999).

). Hellison and Templin suggested that the psychosocial behaviors of students can be changed gradually through a structured physical activity (PA) program and can develop self-control, respect for the rights and feelings of others, participation and effort, caring and helping, and self-directions. Wright and Sugden, stressed that a structured PA program is not only about physical training but should also conder students´ cognitive, emotional, and social development. Wright and Sugden believed that “learning to move” and “moving to learn” (p.16) complement each other and are important outcome of physical education and structure PA programs.

## Or…..

### THE DRUM BEAT – Chemnitz Drumming Project

…is a worldwide, unique research project that was initially created to answer scientific questions as well as deriving and evaluating social and medical measures using the characteristics of drumming and movement. THE DRUM BEAT was inspired by a research project of the University of Gloucestershire and University of Chichester, titled the “Clem Burke Drumming Project” where for the first time worldwide investigations on the physical demands of drumming/percussion were established. The Chemnitz University of Technology [CUT] was invited to participate in this collaborative research and extended the research focus by using cognitive parameters besides many others.

The Drum Beat therefore evolved out of the before mentioned project, and strives to investigate the broader application of different types of drumming, movement and exercise with an interdisciplinary team of scientists, musicians, teachers, physicians, therapists and communal authorities. All teams are working towards establishing interventions and structures to provide positive effects using the common language of drumming and movement. Drums Alive ®, the first fitness trend that combines drumming and movement to provide health benefits through a multi-modular approach, was identified as one of the key interventions of study for its practicality and holistic approach amongst others.

Therefore, THE DRUM BEAT seeks to investigate and apply all aspects of drumming in one inter-disciplinary project for the benefit of society in the context of physical and mental health, social challenges, inter-cultural aspects, music and education.

# 1 Introduction

Drumming is used as a universal intervention to achieve socially relevant health strategies as well as educational, social and cultural effects. Furthermore, the related structures are collectively upgraded and evaluated scientifically. The aims of the Chemnitz DRUM BEAT project are accordingly varied and can be structured in three areas:

- research psychological, social and medical effects of drumming.
- derive basic knowledge relevant to the occupational health of drummers.
- identify the application possibilities of drumming for an overall intervention concept for society, for example in:

    - Schools: physical and musical education as well as cognitive effects – i.e. by using active mathematics classes that combine bursts of high intensity movement interspersed with periods of recovery, cognition exercises which also might help with learning disabilities.
    - Therapy: management of aggression, therapy of ADHD, obesity, Parkinson's disease and depression as well as the application in cardiac rehabilitation and others.
    - Sports/leisure time: joyful introduction to an active lifestyle for youths and older people.
    - Culture: drumming as a possibility to initiate interest in culture/music as well as using exercise and music as an artistic way of expression.
    - Social: supporting measures on exposure to social fringe groups such as drug addicts, school truancy, and integration of foreign fellow citizens or disabled citizens.

The *Charity for Health Promotion and Exercise Therapy* (German: Verein für Gesundheitssport und Sporttherapie Chemnitz e.V)" works closely with an inter-disciplinary team from the University of Chemnitz, municipal authorities, schools and various companies to realize these aims.

In addition, through the extensive, consistently positive response, which the project has already received at such an early point of time, we are already extending the network to countries such as Australia, the UK, Slovakia, Slovenia and the USA. *It would be a pleasure to welcome you too as one of our partners.*

Therefore, this document should give you an overview of the project THE DRUM BEAT and its potential. The enclosed CD also gives you a vivid impression of the project.

## 2.2 Intervention

Drums Alive is an integral, health-conscious training concept, combining rhythm and exercise in a unique way. Drumming on large gymnastic balls is combined with different movements and unites physical aspects of exercise with creativity and the social component of drumming in a group. Therefore, Drums Alive appears to be extremely motivating and in a position to improve physical fitness, coordination and possibly brain function. It is the task of science to explore these effects and develop intervention strategies. Working with music, rhythm and especially cross-coordinative movements has potentially various positive effects. First results are hinting at positive changes in concentration and awareness and possibly other cognitive and emotional effects. Latter could possibly also cause an activation of neurological pathways and theoretically a balance of the right and left brain hemisphere.

Thus, varied new possibilities with universal effects could impact on areas such as exercise and psychological therapy as well as in the wide area of education under the motto *"active learning".* The social aspects of drumming and dancing/exercising in a group with its manifold evolutionary aspects need to be taken into account. Therefore, the promotion of social competence is an important component.

Drums Alive has already successfully been used in a medical and cross-cultural context and anecdotal evidence shows the great potential of drumming interventions in the wider health promotion. Cultural inequalities can be addressed by using music and rhythms from different countries as well as interaction and non-verbal communication that comes with it. Furthermore, it is a fact that children learn more effectively in a playful way and using rhythm. Because everyday life in school cannot always be playful, and learning requires concentration and motivation, a concept of rhythmical learning can be a practical alternative to increase pleasure during school. Drumming or rather playing the drum could give an effective learning aid for pupils in classrooms. However, science still has to research these new concepts of learning and movement/exercise.

## UNIV. OF CHEMNITZ RESEARCH IN HEALTHY ADULTS

# Changes of physiological parameters in a sportive DRUMS ALIVE®-Drumming Activity and its effects on concentration and awareness performance

**THE DRUM BEAT – Chemnitz Drumming Project**

PETER WRIGHT, PETER EHNOLD, REGINA ROSCHMANN, ISABEL WOLF
Chemnitz University of Technology; Germany

## Objectives

This article will discuss the interim results of a study that investigated a fitness trend that uses elements of drumming and aerobics called Drums Alive®. The focus of the analysis lies on the behaviour of physiological parameters during this intervention in adults of different ages. This should produce information on the typical work intensity of this exercise. Furthermore, the effects on acute concentration and awareness performance after a session of Drums Alive® in students were investigated. The here presented study is part of a bigger project „THE DRUM BEAT – Chemnitz Drumming Project“, which evaluates the possibilities of using this type of drumming exercise in various areas of fitness, education and therapy.

## Methods

The study design included two sessions to allow the subjects to get used to the movement patterns of Drums Alive® and a third testing session with 27 adults (14 students, 18-22 years and 13 older adults who were between 30 and 65 years of age, described here as AC 30-65). During the testing session physiological data was collected which included heart rate, blood lactate, range of perceived exertion and exemplary spirography data in two subjects as well as concentration and awareness tests using the d2-test in the students group only (N=16; the d2 students intervention group had two more subjects in this group compared to the physiological data). In order to compare the latter data (concentration performance) a control group of 17 students was used.

## Results

All physiological parameters showed a significant increase compared to the resting values. The intervention can therefore be described as an effective exercise. The blood lactate values showed a mean increase from 1.16 ±0.31 to 3.75 ±1.91 [mmol/L] in the overall group (students and AC 30-65, N=27), which corresponds with the changes in heart rate. An increase from 84 ±14 to 155 ±16 could be shown. This is also reflected in the high RPE-values of 16 towards the end of the main phase of the Drums Alive® session. The results of the d2-tests showed a slightly better performance in the intervention group (students) compared to the control group, but no significant difference.

## Conclusions

This study proved significant physiological effects in the Drums Alive® exercise session and gave hints on a positive effect on concentration performance. However, more research is necessary before a final statement on the effects of this type of sportive drumming exercise can be given.

# INFORMATION ON DEVELOPMENTAL DELAYS IN CHILDREN

http://raisingchildren.net.au/articles/developmental_delay_d.html

Developmental delay is the term used when a young child is slower to develop physical, emotional, social and communication skills than is expected in children of that age.

## About developmental delay

Developmental delay can show up in the way a child moves, communicates, thinks and learns, or behaves with others. When more than one of these things is affected, the term 'global developmental delay' might be used.

Developmental delay might happen just in the short term or it might be long term or permanent.

## Causes of developmental delay

Lots of different things can cause children to develop more slowly than their peers.

Usually health professionals use the term 'developmental delay' only until they can work out what's causing the delay. If and when they find the cause, they'll use a name that better explains the child's condition.

Short-term developmental delays can happen in premature babies. Other causes for short-term delays are physical illness, prolonged hospitalisation, family stress or lack of opportunity to learn.

Permanent developmental delays are also called 'developmental disabilities'. These can be signs of other conditions. Examples include:

- cerebral palsy
- language delay
- hearing impairment
- intellectual disability
- autism spectrum disorder.

### Diagnosis of developmental delay

Often you might have an idea that there is a problem with your child's development long before it's diagnosed by a professional.

**You know your child better** than anyone else. So if you're concerned about your child's development, it's a good idea to start by talking to your GP or child and family health nurse.

Developmental delay can be diagnosed after a child's health and development are assessed by qualified health professionals.

### Living with developmental delay

Like other children, children with developmental delay keep learning. But they take longer to develop new skills, and might learn in slightly different ways.

For example, most children can learn skills quickly and by example. But children with developmental delay might need to be shown skills in smaller, simpler steps. They might also need more opportunities to practise.

## *Recognizing Developmental Delays in Children (C & D See the end of the paper for more information)*

As you watch your child grow, remember that each child develops at his or her own pace and the range of normal is quite wide. However, it is helpful to be aware of red flags for potential developmental delays in children. These delays are significant lags in one or more areas of emotional, mental, or physical growth. If your child experiences a delay, early treatment is the best way to help him or her make progress or even to catch up.

# What Are Developmental Delays in Young Children?

There are many different types of developmental delays in infants and young children. They include problems with:

- language or speech
- vision
- movement -- motor skills
- social and emotional skills
- thinking -- cognitive skills

Sometimes, a delay occurs in many or all of these areas. When that happens, it is called "global developmental delay." Global developmental delay may occur for any of the following reasons:

- a genetic defect, such as Down syndrome
- fetal alcohol syndrome, caused by a mother drinking alcohol during pregnancy

- fragile X syndrome, an inherited type of cognitive impairment
- severe medical problems developing soon after birth, often associated with prematurity
- often no cause can be found

# Prevention science and positive youth development: Competitive or cooperative frameworks? (Review)

Catalano, R.F. ,
Hawkins, J.D.,
Berglund, M.L.,
Pollard, J.A.,
Arthur, M.W.

Social Development Research Group, School of Social Work, University of Washington, 9725 3rd Avenue N.E. #401, Seattle, WA 98115, United States

Drumming is a non-verbal, universal activity that builds upon a collectivistic facet of diverse cultures and does not bear the stigma of therapy.

]. Positive youth development interventions facilitate positive outcomes through developmentally appropriate achievements intended to address the “whole child" [39].

*“Prevention science and positive youth development: competitive or cooperative frameworks?” Journal of Adolescent Health, vol. 31, no. 6, pp. 230–239, 2002. View at Publisher · View at Google Scholar*

## Journal of Adolescent Health
Volume 31, December 2002, Pages 230-239

## Abstract

Purpose: To examine the convergence in the critiques and recommendations for the future of programs to promote healthy development and prevent problem behaviors among children and adolescents. Methods: A review of literature captures two streams of thought, those promoting positive youth development approaches to youth programming and those promoting prevention science approaches to youth programming. Results: Results suggest

that advocates of positive youth development and prevention science have similar critiques of single-problem-focused prevention programs in the 1980s and early 1990s, and have similar recommendations for the future of youth programming. Further, review of data on youth development suggests that it is important to focus on risk and protection in preventing adolescent problems as well as in promoting positive youth development. Conclusions: These results suggest that both youth development and prevention science approaches have grown from similar roots and make similar recommendations for the future of youth programming. Further, data on precursors suggest that focusing on promoting protection and reducing risk is likely to prevent problems and promote positive youth development. Yet advocates of these approaches often are at odds, suggesting that the approaches provide different paradigmatic approaches to youth programming. We conclude that cooperation between these two approaches would further progress in the field of youth programming. © Society for Adolescent Medicine, 2002.

*https://www.scopus.com/record/display.uri?eid=2-s2.0-0036894408&origin=inward&txGid=4B7BF6F46B3BBF1A474E379EE87AD8AD.wsnAw8kcdt7IPYLO0V48gA%3a2*

Research has shown that SEL is fundamental to children's social and emotional development—their health, ethical development, citizenship, academic learning, and motivation to achieve. Social and emotional education is a unifying concept for organizing and coordinating school-based programming that focuses on positive youth development, health promotion, prevention of problem behaviors, and student engagement in learning" [5].

*"Collaborative for Academic, Social and Emotional Learning, What is SEL?" 2011, http://www.casel.org.*

## The Scientific World Journal

Volume 2012 (2012), Article ID 152923, 3 pages
http://dx.doi.org/10.1100/2012/152923

Editorial

Positive Youth Development Constructs: Conceptual Review and Application

Daniel T. L. Shek,1,2,3,4,5 Rachel C. F. Sun,6 and Joav Merrick7

Serious mental disorders have considerable individual and societal impact, and traditional treatments may show restricted effects. …

# LEARNING DISORDERS/DISABILITIES

Learning is a core process of human growth and development. It is a key enabler of change in human behavior. Learning results in changes in behavior and the knowledge, skills and emotional reactions underlying behavioral. Through learning we can adapt to changes in our environment and also actively influence our environment and our own behavior as part of it. Learning is always an active and interactive process which takes place in a cultural and social context. Experiences obtained from the growth environment both cause and regulate learning. PHYSICAL Activity AND LEARNING • SUMMARY

"Learning disabilities are not a prescription for failure. With the right kinds of instruction, guidance and support, there are no limits to what individuals with LD can achieve."
Sheldon H. Horowitz, Ed.D., Director of LD Resources.
National Center for Learning Disabilities:

The DSM uses the term "specific learning disorder." Revised in 2013, the current version, DSM-5, broadens the previous definition to reflect the latest scientific understanding of the condition.

> The diagnosis requires persistent difficulties in reading, writing, arithmetic, or mathematical reasoning skills during formal years of schooling. Symptoms may include inaccurate or slow and effortful reading, poor written expression that lacks clarity, difficulties remembering number facts, or inaccurate mathematical reasoning:
>
> Current academic skills must be well below the average range of scores in culturally and linguistically appropriate tests of reading, writing, or mathematics. The individual's difficulties must not be better explained by developmental, neurological, sensory (vision or hearing), or motor disorders and must significantly interfere with academic achievement, occupational performance, or activities of daily living.
>
> Specific learning disorder is diagnosed through a clinical review of the individual's developmental, medical, educational, and family history, reports of test scores and teacher observations, and response to academic interventions.

(*Specific Learning Disorder* fact sheet, American Psychiatric Association, 2013) The State of Learning Disabilities: Facts, Trends and Emerging Issues | LD.org

# LEARNING/INTEGRATION/COMMUNICATION

## PEDIGOGIC RESEARCH FROM HANKA KÜHN – Department of Education – University of Chemnitz, Germany (Chair????)

Sub-Project Partners: Charity for health promotion and exercise therapy & the chairs of intercultural communication, sports sociology, sports medicine.

A further aspect of Drums Alive is the so called “Cultural Drumming”. It will be integrated as a contribution of an intercultural training in the context of a secondary school’s project week. The aim is the development, realisation and scientific supervision of an intercultural training for pupils. Thereby, “Cultural Drumming” is an intervention for communicating non-cognitively, especially addressing physical aspects of intercultural competence. It will also be combined with applied geographical learning contents. Thus, the handling of physical and cultural differences will be trained. The project is conducted together with ethics-, music- and geography teachers.

With the assistance of standardised test procedures, the concentration and awareness performance of the participants is measured before and after a class of drumming throughout almost every sub-project. These tests are also conducted in other sportive activities, such as running and cross-country skiing for comparative reasons. In this case the main objective is to measure possible effects of different types of exercise and especially of drumming in order to take a first step towards more sophisticated neurological and brain research.

## 2.3.4 Motor Pedagogy

In addition to the already explained pedagogical concepts, the Exercise education is a significant part of the project week. The According to Rebel (1999), physical education provides a holistic need and education Lebensweltlichen approach. Under motion education one understands "The exploration and teaching of nonverbal communication material under special Consideration of human movement in everyday interaction and in artistic actions to help them in social, educational, prophylactic, effective use of therapeutic and artistic work areas. "(Rebel 1999, p. 9)  Rebel, Günther (1999): Bewegungspädagogik im Sozialwesen. Eine Einführung.

***2.3.4 Bewegungspädagogik***

*Neben den bereits erläuterten pädagogischen Konzepten nimmt auch die Bewegungspädagogik einen bedeutenden Teil der Projektwoche ein. Die Bewegungspädagogik stellt laut Rebel (1999) einen ganzheitlichen bedürfnis- und lebensweltlichen Ansatz dar. Unter Bewegungspädagogik versteht man „die Erforschung und Lehre von nonverbalem Kommunikationsmaterial unter besonderer Berücksichtigung der menschlichen Bewegung in der alltäglichen Interaktion und in künstlerischen Aktionen, um sie in sozialen, pädagogischen, prophylaktischen, therapeutischen und künstlerischen Arbeitsbereichen wirkungsvoll einzusetzen.“ (Rebel 1999, S. 9)*

*Rebel zufolge geht es um die „Förderung durch Aufklärung und Bildung zu einer selbstverantwortlichen und gemeinschaftsfähigen Persönlichkeit“ (ebd., S. 18f.). Seine Festlegung der Grob- und Feinziele der Bewegungspädagogik sind der Tabelle 1 zu entnehmen.*

**Example: Waxmann.**
According to Rebel, it is about the "promotion through education and education to one self-responsible and sociable personality "(ibid., p. 18f.). His Definition of the coarse and fine goals of physical education are given in Table 1

| Coarse objectives of movement education | Fine goals of movement education |
|---|---|
| Movement awareness | This is about material analysis such as: What is body language, and which is nonverbal Signs are perceived? |
| Body Control | This is about the situational, selective and receptive understanding of body language and order expressive communication through movement. Using personal social skills like Adaptation and independence body language rules, their meaning and Effect in certain situations self-critical and critical to be interpreted to act appropriately at all times. |
| Expressions of expression | Feelings are expressed through physical Moving out, as well as feelings and Influence mind through movement. a Feelings can be caused by body actions mental locks are opened, causing aggression towards others or the one prevent your own person. Expressiveness is automatic in everyone Created people. That's why through Training also an expression extension be achieved. |

Tab. 1: Coarse and fine goals of physical education according to Rebel (1999)

"The behavior of every organism, including that of man, is nothing other than his reaction to certain environmental stimuli that helps the organism to the environment adapts. Behavior

is the visible result of stimulus-response compounds that the Organism - starting from some elementary innate reflexes - in the course of the learner

Time has learned. Under this perspective, learning is thus the construction of new stimuli Reaction compounds that lead to relatively permanent behavioral changes. " (Baumgart 2001, p. 109)

Baumgart, Franzjörg (Hg.) (2001): *Entwicklungs- und Lerntheorien. Erläuterungen, Texte, Arbeitsaufgaben*. 2., durchgesehene Aufl., Bad Heilbrunn, Obb.:Klinkhardt.

# Pub Med

US National Library of Medicine National Institutes of Health
Res Dev Disabil. 1988;9(1):73-83.

# Reducing inappropriate behaviors of developmentally disabled adults using antecedent aerobic dance exercises.

Bachman JE[1], Sluyter D.

**Author information**

## Abstract

The effects of aerobic dance exercise on inappropriate behaviors of two developmentally disabled adults were observed in a day activities center. The experimental phase, in which the subjects engaged in exercise with seven other individuals on Monday, Wednesday, and Friday of each week, was preceded and followed by baseline phases in which subjects did not exercise and in which there were no contingencies in effect for the dependent variables. Exercises consisted of those commonly used in exercise dance classes. Observations occurred during 15 minute periods immediately before and following exercise while subjects engaged in regular classroom activities. Observations also occurred in the same time periods on no-exercise days during all phases. Behaviors observed included inappropriate vocalizations, repetitive movements, and off-task. Results indicate for both subjects a decrease in each of the inappropriate behaviors as a result of exercise.

PMID:
3353543
[Indexed for MEDLINE]

## READING DISABILITIES

In children with reading disabilities, a school-based programme of balance and coordination training, throwing, catching, and stretching produced significant improvements in both reading and semantics. [79] Positive changes were maintained for at least 18 months following the programme, reducing the likelihood of a Hawthorne effect. [80]

***79*** *Reynolds D, Nicolson RI, Hambly H: Evaluation of an exercise-based treatment for children with reading difficulties. Dyslexia. 2003, 9: 48-71. 10.1002/dys.235.Google Scholar*

***80*** *Reynolds D, Nicolson RI: Follow-up of an exercise-based treatment for children with reading difficulties. Dyslexia. 2007, 13: 78-96. 10.1002/dys.331.*

**https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-10**

# SOCIAL & MOTOR SKILLS IN AUTISM

## Abstract

Motor and social competence are delayed in children with autism spectrum disorder (ASD). Social interaction and functional physical capacity play an important role for developing peer relationships in school settings such as gym, playground, and classroom. Research on the delayed motor competence in relationship to poor social interaction in children with ASD is limited. The purpose of the study was to examine motor competence and social skills functioning in children with ASD. A sample of 23 children diagnosed with ASD participated in the study. Bruininks-Oseretsky Test of Motor Proficiency-II (BOT-2) was used to examine children's motor competence and Autism Social Skill Profile (ASSP) survey was given to parents to assess children's social skills functioning. The descriptive analysis revealed that 87% of the children with ASD were classified as below average or well below average category in BOT-2 suggesting the children with ASD were delayed in motor competence. In addition, 52% of the children were ranked at or below 50th percentile on the ASSP indicating that they had poor social skill functioning. A significant positive correlation was found between BOT-2 and ASSP revealed that children with ASD who performed poorly in BOT-2 also scored low in ASSP. These findings suggest that including fine and gross motor skills in the treatment interventions for children with ASD may improve their health-related wellbeing and maintain positive socialization.

**Key Words: autism; children; fine and gross motor competence; social skills**

Autism Spectrum Disorder (ASD) is a neurological disorder in which a child exhibits delayed motor competence and deficits in social interaction (CDC, 2017). The occurrence of ASD in US was reported about 1 in 150 children in 2007 and the prevalence of ASD has increased to 1 in 68 children in 2012 (CDC, 2012). Many children diagnosed with ASD are delayed in fine and gross motor proficiency (Berkeley, Zittel, Pitney, & Nicholas, 2001; CDC, 2017; Liu, 2013; Manjiviona & Prior, 1995), demonstrate stereotypic behavioral patterns (APA, 2013; Liu, Fedak, & Hamilton, 2016; Pusponegoro et al., 2016), and show impaired social interaction (Liu et al., 2016; CDC, 2017). Most children with ASD also experience sensory abnormalities resulting in increased sensory seeking behavior so they tend to respond to the sensory input with repetitive movements like flapping arms, twirling, and rocking (APA, 2017; Ben-Sasson et al., 2009). Atypical sensory responses, specifically in tactile and auditory filtering, can affect a child's motivation to participate in physical activity and lead to delays in fine and gross motor competence. Few other symptoms of ASD include social functioning deficits of inability to understand facial expressions, difficulty in verbal expression of emotions, and understanding the concept of sharing the toys and taking turns in the classroom or playground (CDC, 2017).

While the research on diagnosing and managing ASD is still ongoing, few researchers argue that the relationship exists between the ASD symptoms. For example, children with ASD sensory impairments were related to their poor motor competence (Hilton et al., 2010; Liu, 2013) and poor motor competence was related to their social skill deficits (Berkeley et al., 2001; Fournier, Hass, Naik, Lodha, & Cauraugh, 2010; Lindsay, Hounsell, & Cassiani, 2017; MacDonald, Jaszewski, Esposito, & Ulrich, 2011; Pusponegoro et al., 2016). Hilton et al. (2010) examined the relationship of 36 high functioning children with ASD social response and their sensory profile. They reported that the sensory abnormalities were strongly related to the social deficits in children with ASD. Liu (2013) examined children with ASD's motor competence using movement assessment battery for children (MABC-2) and sensory profile using a short sensory profile (SSP). It was reported that the children with ASD were delayed on their fine and gross motor skill performance including manual dexterity, catching and throwing of ball, and balancing. It was also found that the children with low sensory processing scores also showed poor motor competence. Children with ASD with deficits in motor and social functioning may have limited physical functional capacity to participate in sports and less opportunity to be invited to participate in group activities on the playground as their typically developing peers.

Furthermore, Puspnegoro et al. (2016) conducted a cross-sectional study on children with ASD, aged 18 months to 6 years, using Vineland Adaptive Behavior Scales-2 to compare their motor competence with 40 typically developing children. The results showed that most of the children with ASD scored below average in gross motor abilities of rolling a ball, object manipulation, hopping upward and forward on one foot, kicking a ball, and able to use alternate feet while using stairs. It was also found that the children who scored below-average in gross motor skills have scored low to moderately low in social skills. Research suggests that in addition to motor and sensory delays, children with ASD also found to have poor social

skills such as difficulty in making eye contact, withdrawing from social situations, showing least interest in meeting other people (CDC, 2017; Puspnegoro et al., 2016; Rivard et al., 2016). Rivard et al. (2016) stated that children with ASD had hard time in voluntarily initiating conversation and showed less spontaneous minimal social initiation behaviors when compared to their peers. Children with ASD also tend to make inappropriate comments or dominate conversations with their personal interests that keeps them from engaging in positive social interaction (Bellini, 2006b; Kaale, Smith, & Sponheim, 2012). Many children with ASD also exhibit socially inappropriate behaviors like physical aggression, self-injury, property damage, and inappropriate refusal of screaming and pushing instead of saying "no" (Rivard et al., 2016).

Specifically related to conversation-social skills, children with ASD also tend to make inappropriate comments or dominate conversations with their personal interests that keeps them from engaging in positive social interaction (Bellini, 2006a; Kaale et al., 2012). For example, Hagopian, Kuhn, and Strother (2009) reported that as a therapist was talking about colors, the child interrupted and changed the topic by asking "Do you like horses?" This study also reported that the scores of the child's frequency of inappropriate touching were high with a mean of 92% (Hagopian et al., 2009). The poor social skills functioning in children with ASD may lead to a larger effect of detrimental social behaviors that are disruptive to creating social relationships and eventually resulting in limiting peer relations.

Previous studies are available on existing social skill deficits, assessing social skills, and designing treatment programs in children with ASD (Bellini, 2006b; Kaale et al., 2012; Rivard et al. 2016. However, they are limited on how these social deficits are related to other existing symptoms in children with ASD like motor competence. Knowing this relationship is valuable and beneficial in helping educators and practitioners designing early intervention treatment programs to improve children's motor competence and social skill functioning (MacDonald, Lord, & Ulrich, 2013). Furthermore, understanding this relationship may assist children with ASD to adjust in the school settings (Liu et. al., 2016), improve academic performance (Nicholson, Kehle, Bray, & Heest, 2011), develop social relationships (Fuller et al., 2013; Legoff, 2004), and enhance quality of living (Tan, Cohen, & Pooley, 2013; Toscano, Carvalho, & Ferreira, 2018). Because low motor competence is related to poor social interaction in children with ASD, understanding how motor competence may affect their social skill functioning is important. Thus, the purpose of the study was to examine the relationship between motor competence and social function in children with ASD. It was hypothesized children with ASD's social skill function were positively related to their motor skill competence.

## Method

*Participants*

Initially, a sample of 25 children with ASD (24 male and 1 female) aged 4-16 years were recruited for the study. Children were included in the study if (1) they were diagnosed with ASD by a physician or a school psychologist based on DSM-IV criteria (APA, 2000) and (2) they could follow instructions and communicate with the testing administrators to complete the fine and gross motor skill performance. Two participants were excluded from the study because they were unable to finish the required motor assessments. Therefore, a total of 23 children with ASD (all males) completed all assessments and were included in the study. This study was approved by the local University Institutional Review Board. The parents were informed about the protocol and signed the consent form prior to their child's participation in the study.

***Instrumentation***

***Bruininks-Oseretsky Test of Motor Proficiency-2(BOT-2; Bruininks & Bruininks, 2005)***

The BOT-2 is an assessment tool to test motor competence of children with ASD. The short form with knee pushup test was used in this study to assess both fine and gross motor skills in children with ASD. The BOT-2 short form consists of eight subtests with a total of 14 tasks in which scores on four subtest measures fine motor competence: 1) fine motor precision (FMP), 2) fine motor integration (FMI), 3) manual dexterity (MD), and 4) bilateral coordination (BC), and four subtests assess gross motor competence: 1) balance, 2) running speed and agility (RSA), 3) upper-limb coordination (ULC), and 4) strength.

The raw scores were converted to a point score using the conversion table provided on the form. For example, if a child scored 12 in drawing lines through paths, the item score was converted as a 2-point score. Children performed two trials for each task and the better score of the two was selected. Total point scores were recorded by adding all point scores and using the norm tables to find percentile rank and standard scores. The range of percentile rank of each child's scores for interpretation are as follows: 2 or less (well-below average), 3-17 (below-average), 18-83 (average), 84-97 (above average), and 98 or greater (well above average).

***Autism Social Skills Profile (ASSP; Bellini & Hopf, 2007)***

The ASSP is a caregiver survey that includes 49 items on a 4-point Likert scale. This assessment tool provides a comprehensive measure of social functioning in children with ASD with the age range of 6 to 17 years. The ASSP consists of three subscales, Social Reciprocity (SR), Social Participation/Avoidance (SPA), and Detrimental Social Behaviors (DSB), and the overall social functioning. For example, the skill area of "recognizes the facial expressions of others" from the survey is related to SR. The social behaviors in children with ASD were rated as: 1 = never, 2 = sometimes, 3 = often, or 4 = very often. The point scores of all the questions were added together for analysis using ASSP summary form (Bellini, 2006a). The ASSP summary form includes the type of ASD in high-functioning or low-functioning and non-verbal or cognitive disability. Total raw scores were converted to percentile rank using ASSP

summary form and the percentile scores were used to analyze children with ASD's social functioning.

***Procedures***

Proper attire instructions were given to the parents prior to the testing administration. The research assistants and graduate students underwent an intensive training session to understand the concepts and instrumentation of BOT-2 prior to the testing by the principle investigator. Initially the research assistants received a lecture on how to implement, score, convert scores and minimize the testing errors. Later mock testing criteria were used to get familiarize with specific emphasizing on how to verbally instruct the child for each task. Research assistants were considered trained after they reach 90% agreement with the principal investigator.

Participants received verbal instructions and visual demonstration prior to each task. Each participant was given a practice trial until the skill was performed correctly as instructed on the manual of BOT-2. When a participant failed to meet the criteria on the BOT-2 manual, additional instruction and demonstration were given. The raw scores were recorded and later converted to point scores. Standard scores and percentile ranks were used to classify a child to a specific motor competence category. In addition, parents were asked to fill out the ASSP form assessing their child's social functioning. The verbal instructions were given to parents prior to answering the questions on the survey.

*Data Analysis*

Descriptive analyses were used to assess children with ASD's motor competence and social skill functioning. A Pearson correlation was run to analyze the relationship between percentile scores of BOT-2 and ASSP. The significance was set at a p value of 0.05. The effect sizes (ES) were also calculated to examine the practical significance (Cohen, 1988). ES can be identified as small (d = .2), medium (d = .5), or large (d = .8).

**Results**

The descriptive analysis showed that 87% of the children with ASD were in the below average or well below average category in BOT-2 suggesting that children with ASD had poor motor competence when compared to the norms (Table 1). The descriptive percentile ranks for ASSP revealed that 52% of the children were ranked at or below $50^{th}$ percentile indicating that children with ASD had poor social skill functioning.

A Pearson correlation was performed to examine the relationship between the percentile ranks of BOT-2 (motor competence) and ASSP (social functioning). A significant positive correlation was found between BOT-2 and ASSP ($r = 0.36$, $p < 0.05$). This finding suggests that children with ASD who performed motor skills poorly in BOT-2 also scored low on their social function in ASSP.

[Inset Table 1 Here]

The effect size (Table 2) of the children with ASD's BOT-2 scores in comparison to the norms were large for FMI (ES= -1.26), MD (ES= -1.05), BC (ES= -0.98), balance (ES= -1.27), and very large for strength with knee push-ups (ES= -2.06). The ES for ASSP (Table 3) describing various areas of social skill functioning were large for SPA (ES= -1.27), and very large for SR

(ES= -3.21), DSB (ES= -6.4), and overall social functioning (ES= -8.59). The large ES values (>0.80) agreed with the statistically significant results that suggests the true effect of the delayed motor and social skills exist in the population.

**Discussion**

The results of this study supported the hypothesis that children with ASD showed low motor and social competence. In addition, the hypothesis of significant positive correlation between the motor competence in BOT-2 and social skill functioning in children with ASD was supported. These findings suggested that children with ASD who had poor motor competence also exhibited deficits in social functioning. In addition, there was a very large effect for fine motor integration, manual dexterity, bilateral coordination, balance, and strength indicating that children with ASD had low motor competence and the practical significance exists in this population. These findings were consistent with previous research that children with ASD were delayed in fine and gross motor competence (Berkeley et al., 2001; Downey & Rapport, 2012; Liu, 2013; Liu & Breslin, 2013; McPhillips et al., 2014; Provost, Lopez, & Heimerl, 2007). More specifically, the majority of children with ASD (87%) in this study demonstrated low motor competence was similar to the Provost et al. (2007)'s study that 84% of children with ASD were classified as significantly delayed in their motor proficiency and also in Liu and Breslin (2013)'s study that 80% of children with ASD showed significant fine and gross motor delays.

The results of 52% children with ASD showing significant social functioning difficulties was consistent with previous studies that reported 50% of children with ASD displayed social skill deficits (Bellini, 2006a; Kaale, et al., 2012; Mayes, & Calhoun, 1999; Puspnegoro et al., 2016; Rivard et al., 2016; VanMeter, Fein, Morris, Waterhouse, & Allen, 1997). The large ES were found in social reciprocity, detrimental social behaviors, and overall social functioning in children with ASD also suggested that the practical significance existed in children with ASD. Researchers have indicated several contributing factors to lack of reciprocal conversation skills with others (Bellini, 2006a; Kaale, et al., 2012). These included limited initiation of interaction (Mayes et al., 1999; VanMeter et al., 1997), difficulty understanding the concept relating to personal space (Parsons, Mitchell, & Leonard, 2004), and existing stereotypic behaviors such as repetitive hand movements and throwing objects that may result in injury (Watt, Wetherby, Barber, & Morgan, 2008).

In addition, the finding of children with ASD's fine and gross motor competence was significantly related to their social skills was in agreement with previous studies (MacDonald et al., 2013; Rivard et al., 2016; Watt et al., 2008). MacDonald et al. (2013) examined 35 children with high-functioning ASD on their motor competence and social communicative skills. It was found that children with greater motor competence showed better social communicative skills. As reported in our study, there were large effect sizes found on the ASSP for overall social performance in relation to motor competence in BOT-2. Furthermore, this study and others indicate a strong connection between motor competence and social functioning in children with ASD. Therefore, it seems reasonable to propose that motor skill

interventions to be paired with social skills as the treatment programs to enhance children with ASD's quality of living. This study provides new valuable findings to researchers, educators, practitioners, and therapist that children with ASD are delayed in their fine and gross motor skills and social functioning as well as the fact that the motor competence and social skill functioning is correlated. Future researchers are recommended to focus on motor competence alongside social, sensory, behavior, and cognitive competencies when designing training, treatment, and intervention programs for children with ASD.

Moreover, the nature of the motor intervention was specific to the needs of children with ASD in structure and targeted physical modalities with social skills emphasis. For example, Gutman et al. (2010) studied children with high functioning ASD and found significant and sustained improvements in targeted social skills behaviors after a motor-based intervention. Similarly, Pan (2010) found that a very specific type of water exercise swimming program led to significant social improvements in children with ASD.

Overall, the findings of this study give rise to the implication of designing motor intervention programs that can best target the specific social skill behaviors (Bellini, 2006a). Structured and prolonged social skills intervention can have positive effects on anxiety and depression in children with ASD (Rumney, & MacMahon, 2017). Thus, it is important to investigate the most effective treatment program to ameliorate social skills to reduce more serious emotional outcomes. These findings also add important implications in examining and determining effective interventions for children with ASD to improve their health-related wellbeing and to maintain their positive socialization and enjoyment of motor activities.

One limitation of this study was the drop in sample size due to incompletion of the motor assessments. Children could not complete or were not willing to finish the BOT-2 assessment were excluded from the study and their data were not included in the data analysis. Also, participants in this study were all males because ASD is about 4.5 times more likely to occur in males than in females. Future study may include more female participants. Furthermore, some of the scores from the ASSP survey was calculated as 0 when the parents indicated the questions were not applicable to the child. Despite additional demonstrations given on the BOT-2 for children who did not appear to understand what was asked of them, there was no guarantee that the child completely comprehended how to perform the task. It is recommended that future research to use picture schedules to help children with ASD better understand the requested motor tasks in BOT-2.

# 5. Conclusion

In conclusion, this study indicates a low motor competence and poor social functioning in children with ASD. A relationship between motor and social skill competence in these children with ASD was found and the needs for designing intervention programs including both motor and social skills. More research is needed to better understand the impact of certain types of motor skills-based activities on successful social development. It is suggested for future interventions to incorporate small instructor to student ratio to enhance

the opportunity for effective social practices with appropriate physical activities, which may strengthen the social skills outcomes for children with ASD. It is also recommended for teachers, therapists, parents, and practitioners to include motor and social skills in their practices when working with children with ASD so that they can then be more generalizable to other settings such as classroom, playground, home, and neighborhoods.

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## BRAIN & MOTOR DEVELOPMENT

***THIS IS A GOOD STUDY***

# Optimizing Early Brain and Motor Development Through Movement

*By Carl Gabbard, Ed.D., and Luis Rodrigues*

It appears that research is now supporting what we in early childhood education have been saying for years. That is, positive early experiences forge the foundations for lifelong learning and behavior. And, to optimize the development of each child, a rich nurturing environment is required **(Diamond & Hopson, 1998; Fischer & Rose, 1998).** Diamond, M., & Hopson, J. (1998). *Magic trees of the mind: How to nurture your child's intelligence, creativity, and healthy emotions from birth through adolescence*. New York: Dutton.

Such support has been abundant in news articles and journal publications in connection with the importance of early experience in brain development of the young child **(Begley, 1997; Nash, 1997).** Begley, S., (Spring/Summer 1997). How to build a baby's brain. Newsweek Special Issue.
In essence, "rich environments produce rich brains," and an essential agent in this process is movement activity!

Scientists now believe that to achieve the precision of the mature brain, stimulation in the form of movement and sensory experiences during the early developing years is necessary **(Greenough & Black, 1992; Shatz, 1992).** Greenough, W. T., & Black, J. E. (1992). Induction of brain structure by experience: Substrates for cognitive development. In M. Gunnar & C. Nelson (Eds.), Minnesota Symposia on Child Psychology. Vol. 24, Developmental Behavioral Neuroscience (p. 155-200).

Experience appears to exert its effects by strengthening and bonding synapses, which are the connections that are made between neurons. Connections that are not made by activity, or are weak, are "pruned away," much like the pruning of dead or weak branches of a tree. If the neurons are used, they become integrated into the circuitry of the brain. Due to differences in experience, not even identical twins are wired the same **(Chugani, 1998).** Chugani, H.T. (1998). A critical period of brain development: Studies of cerebral glucose utilization with PET. *Preventive Medicine*, 27, 184-188.

The primary basis for the importance of movement and sensory experiences was derived from studies which compared brain structures of animals raised in various environmentally normal, deprived, and enriched settings. The enriched settings provided the opportunity to interact with toys, treadmills, and obstacle courses. Overall, such research has led to the conclusion that stimulation is a significant factor in overall brain development **(Jones & Greenough, 1996; Kempermann & Gage, 1999).** Animals placed in enriched environments had brains that were larger and contained more synaptic connections.

## Windows for Motor Development

For basic gross-motor skills, the general window of opportunity appears to be open from the prenatal period to around age five. Once again, this is a period in which experience is vital to laying the "foundation" of brain circuits dedicated to motor control. The primary motor circuits that connect to the cerebellum, which controls posture and coordination, forge during the first two years. It is during this period that the child begins to gain considerable experience in the world as he or she "moves" about in the environment. Once again it is suggested that physical activity is a strong determinant in the early development of the brain, not just motor control. It seems reasonable that the critical period for finer muscle control and timing, which typically follow gross-motor development, would be open from shortly after birth to about age nine. This information has strong implications for developing the primary circuits needed for learning skills that require a high degree of manual dexterity, such as playing a musical instrument or performing precise manual operations. There is also speculation that the general window of opportunity for most behavioral functions narrows considerably around age 10 **(Chugani, 1998).** Chugani, H.T. (1998). A critical period of brain development: Studies of cerebral glucose utilization with PET. *Preventive Medicine*, 27, 184-188.

### What We Can Do

As noted earlier, the general time frames for the windows of opportunity are still quite speculative. This is especially true in regard to the types and effects of specific movement activities. Nevertheless, few researchers would deny that early movement experiences are critical to optimal brain development. To be of maximum benefit, movement experiences should be introduced early in life and during the windows of opportunity. Certainly, this is not to say that such activities should not be stressed beyond the critical period. Motor skills enhance our lives at all ages and a positive attitude about habitual physical activity sets the foundation for a lifetime of good health.

Although it seems quite reasonable that a comprehensive developmentally appropriate movement program would be effective in enhancing early brain and motor skill development, the following recommendations are offered based on the research discussed.

1. Provide children with lots of sensory-motor experiences, especially of the visual-motor variety. This would include activities that integrate visual information with fine- and gross-motor movements. Such activities include striking, kicking, and catching.

2. Include a variety of basic gross-motor activities that involve postural control, coordination of movements, and locomotion – crawling, creeping, body rolling, and jumping. In addition to stimulating the general wiring patterns of these fundamental skills, moderate and vigorous intensity gross-motor activity provide the brain with its chief energy source, glucose. In essence, these activities increase blood flow, which feeds the brain and enhances neuronal connectivity during the critical period.

3. Combine movement activities and music. Although the jury is still out regarding the relationship between musical experience and specific academic achievement, the combination of music with movement presents an excellent learning medium for young children.

4. What follows are the recently released activity guidelines for children birth to five years and a brief description of appropriate movement activities for infants, toddlers, and preschoolers (NASPE, 2002).

# GOOD STUDY

**Contents lists available at SciVerse ScienceDirect**

**The Arts in Psychotherapy 39 (2012) 107– 116**



## Moving in and out of synchrony: A concept for a new intervention fostering empathy through interactional movement and dance

Andrea Behrends*, Sybille Müller, Isabel Dziobek
Cluster of Excellence “Languages of Emotion”, Freie Universität Berlin, Habelschwerdter Allee 45, 14195 Berlin, Germany

**Keywords:** Empathy Mirror neuron system Synchrony Imitation Movement/dance intervention Autism

**a b s t r a c t**

In this theoretical article, we link literature from different disciplines such as the neurosciences and psychology, dance/movement therapy, dance studies, and philosophy, in order to show that interactional, coordinated movement forms an important base for the development of empathy and prosocial behavior. The presented body of literature suggests that specific elements of joint movement and dance, namely imitation, synchronous movement and motoric cooperation, are suitable for fostering empathic abilities, especially in people with empathy deficits. In the second part of the article, we present a newly conceptualized dance and movement intervention for people with empathy dysfunction, tailored to its first application for people with autism spectrum disorders. Through enhancing and refining kinesthetic empathy skills, we hypothesize within an inte-grative concept of empathy, that both emotional and cognitive empathic processes such as empathic concern and perspective taking can be fostered. With a first treatment outcome study of the presented intervention that we will conduct in the near future with people on the autistic spectrum, we aim at evaluating the program and contributing to the understanding of dance and movement approaches for people with empathy deficits. ©

Introduction Dance, movement and embodiment Joint dance and movement are known for their potential to pro-mote social bonding in many cultures. Moreover, in making use of the interrelation of body, mind and spirit, dance also plays an important role in the healing rituals in many cultures (Chaiklin, 2009). Over the past decade, the body has gained increasing recog-nition in academic research as the crucial platform for perception and expression of emotions and intersubjectivity. Research in the field of embodiment has been expanding in different disciplines such as philosophy, arts, linguistics, neurosciences and psychother-apy. Across those disciplines, it is widely accepted that the dualistic body–mind distinction outlined by Descartes ought to be overcome (e.g., Damasio, 1994). According to enactive or embodied cognitive science approaches (e.g., Fuchs, 2009; Thompson, 2001; Thompson & Varela, 2001), “the mind is not in the brain; it is not located in any one place at all, but is rather distributed among the brain, the body and the environment” (Fuchs, 2009, p. 221). Some authors with a broad conceptualization of intersubjectivity and empathy even call for a simultaneous analysis of the relation between subjectivity and the world (Zahavi, 2001). Dance/movement therapy (DMT) Dance/movement (psycho-)therapy (DMT) is an internation-ally widespread body- and art-based form of psychotherapy for many somatic and psychic illnesses that has been developed since the 1940s with different orientations (Willke, 2007). The thera-peutic use of dance in DMT is based on the essential realization that individuals can, through the medium of dance, relate to the community they are part of, and can simultaneously express their own impulses and needs within that group (Chaiklin, 2009). The body in movement is the main focus of therapy as the central medium for emotion perception and expression and an important source of personal resources and vitality (Quinten, 2008). Ther-apeutic interventions in DMT support kinesthetic and emotional perception as well as expressive and social-communicative skills. DMT is especially effective in strengthening a sense of security in people with alienated or distorted body experiences. DMT is effec-tive in strengthening a sense of security (Waidelich, 2009). It is aimed at the development of a realistic and accepting approach to a person’s own body as

well as at new and positive move-ment experiences (Willke, 2007). Interactive therapeutic elements with creative, cooperative, imitative or synchronous aspects aim at increasing the quality of and possibilities for relationships with other people and are frequent interventions in DMT group treat-ment (e.g., rhythmic dancing in a circle as described in different writings by M. Chace, in Sandel et al., 1993). Dance/movement ther-apy is currently being applied as a part of clinical and outpatient therapeutic schedules for treatment of a wide range of psychiatric diagnoses such as neurotic, psychosomatic, and trauma-related problems (Chaiklin & Wengrower, 2009; Payne, 2006; Quinten, 2008; Trautmann-Voigt & Voigt, 2007). However, to date, rela-tively few treatment outcome studies have been published (e.g., Bräuninger, 2006; Jeong et al., 2005; Koch, Morlinghaus, & Fuchs, 2007; Ritter & Low, 1996) and there exist few diagnosis-specific conceptualizations (e.g., Koch & Weidinger-von der Recke, 2009; Moore & Stammermann, 2009; Weber, 1999). Challenges in DMT research Many dance/movement therapists and dance teachers have expressed the idea that joint movement and dance strengthen bonds between people and make people more perceptive to other people's emotional states. The empathy-enhancing potential of the mirroring of the client by the therapist as a therapeutic interven-tion in DMT has been recently discussed in this journal (McGarry & Russo, 2011), emphasizing the importance and actuality of empa-thy and DMT as a research area. To our knowledge, however, no conceptualization exists to date of the empathy-fostering potential of more general interpersonal coordination processes between par-ticipants in dance and DMT. Furthermore, no prospective research on empathy-fostering qualities of dance and movement methods or specific group interventions has been published. One of the reasons might be that dance and movement in social contexts – and maybe even more therapeutic work in DMT – are difficult to investigate because they are characterized by complex creative and intuitive rather than controlled or standardized processes. Despite the fact that a broad range of methods and techniques that are applied in DMT are well documented (e.g., Willke, 2007), empirical research on how specific DMT elements work is just beginning (e.g., circle dances; Koch et al., 2007). Researchers in the fields of body psychotherapy and DMT have expressed the need for specific research with a focus on the inves-tigation of the effects of key elements of a certain therapy form and the integration of qualitative and quantitative paradigms (Berrol, 2000; Loew & Tritt, 2006). Following trends and standards in psychotherapy research, it has been strongly recommended that a body-psychotherapeutic intervention be comprehensible and manualized with a theory-driven therapeutical conception (Loew & Tritt, 2006). For those reasons, we decided to focus our research on developing and evaluating an empathy-fostering intervention consisting of specific elements of dance and movement while still enabling a comprehensive movement experience. Our research team is constituted as a multidisciplinary group. This allows us to reflect a broad variety of approaches, methodological input, and experience, integrating psychology, dance/choreography, and dance education, child and adolescent psychiatry/psychotherapy, and dance/movement therapy, with additional comments from dance studies and music therapy. Outline of this article In this article, we provide a conceptualization for a 10-week empathy-fostering intervention, entailing interactive movement and dance elements. A first treatment outcome study will be con-ducted in the near future with people on the autism spectrum in a nonclinical setting. As a basis for our reasoning to link move-ment and dance with empathic and interactive abilities, we first summarize dimensions of empathy, its bodily/kinesthetic aspects, and developmental–psychological prerequisites, then provide a review of the literature on perception–action coupling and selected movement elements.

The research hypothesis for our dance and movement intervention study that will start in the near future is as follows: By fostering kinesthetic empathy through a set of interpersonal coordination tasks as key elements, emotional and cognitive empathic capabilities, interactive skills, and prosocial behavior can be enhanced in people with empathy deficits. Dimensions of empathy Multidimensionality of empathy Empathy as an (nonconscious or conscious) intent to share another person's inner state is a fundamental human prerequisite for cooperation and prosocial behavior. The construct of empathy has been researched and discussed from various disciplines such as, psychology, philosophy, psychiatry, and dance studies. Across disciplines and publications, definitions and conceptualizations of empathy vary widely (e.g., Blair & Blair, 2009; de Vignemont & Singer, 2006; Foster, 2011; Lamm, Batson, & Decety, 2007; Singer & Lamm, 2009; Zahavi, 2001). Some authors emphasize the emo-tional or affective response in empathy, whereas others focus more on its cognitive aspects. Affective or emotional aspects of empathy refer to the observer's response to another person's emotional state in the sense of feeling similar emotions in oneself as in the per-son observed or of feeling prosocial emotions toward that person. The cognitive side of empathy comprises mentalizing processes such as, for example, the labeling of emotions, perspective-taking, and inferring mental states. Emotional and cognitive aspects of empathy are interdependent but different processes. This is under-scored by the fact that emotional and cognitive empathic capacities can be developed to different degrees, as shown in individuals with Asperger's syndrome (Dziobek et al., 2008). In this article, we refer to a multidimensional and embodied definition of empa-thy integrating its cognitive, emotional, and corporal/kinesthetic dimensions. The bodily and kinesthetic dimension of empathy The term kinesthesia, although having undergone several revi-sions since its coining in 1880 (Foster, 2011), can broadly be defined as the sensation of movement and body posture, integrating propri-oceptive and other sensory information from inside and outside the perceiving organism (Reynolds, 2007). In line with Foster (2011), a researcher in dance studies/dance history, we argue that in the context of a social interaction, kinesthesia is an important aspect of empathy because it refers to a person's own corporal feeling as a response to the body movements or posture of someone else. Thus, the kinesthetic dimension of empathy allows us to feel the physical state of another person with our own body. Foster (2011) advo-cates an integrative concept of empathy by saying, "The fact that the experience of empathy needs to be qualified with the adjective "kinesthetic' belies the pervasive assumption that emotional and physical experiences are separate" (p. 10). Dance and dance studies provide relevant concepts that can be fruitful for empathy research in other disciplines. Inspired by the psychophysiological research of the early 20th century, dance prac-titioners and researchers like Rudolf von Laban (1966) and John Martin (1936) conceptualized a close connection between motion and emotion in dance and the perception of dance. Recently, the concept of kinesthetic empathy has gained increasing relevance in international conferences and publications in dance and dance studies (Conferences: "Kinesthetic empathy," Manchester, 2010, and "Touching and to be touched – kinesthesia and empathy in dance," Berlin 2011. Publications: Foster, 2011; Reason & Reynolds, 2010). In dance/movement therapy, the concept and processes of kinesthetic empathy (the therapist empathizes and comes into contact with the patient by partly experiencing, sometimes also partly adopting, his or her presented posture or movement qualities) have been playing an important role in therapeutic practice and literature from its inception until today, and are considered to be one of the major contributions of DMT to psychotherapy (Fischman, 2009; Levy, 1992; Sandel, 1993; Schoop, 1974). The first

conceptualizations of empathy (with the term “Einfühlung” by Vischer in 1873, later translated into English by Titchener in 1909) entailed a strong component of kinesthetic sensation, with both Vischer and Titchener seeing empathy as an experience undertaken by one’s entire subjectivity (as reviewed by Foster, 2011). Lipps, who further developed the concept of “Einfühlung” in his work in aesthetics, characterized this aspect of intersubjectivity as a kinesthetically-based process, namely, as a kind of inner imitation of the perceived movements of others (Lipps, 1923, second section). Underlining the importance of the two-sided body in intersubjectivity in a phenomenologic approach, Husserl emphasizes the crucial role of interior bodily self-perception with its possibility of simultaneously exploring one’s own exteriority as an essential precondition for recognizing others and empathy (Husserl, 1973, also see Zahavi, 2001). In the tradition of phenomenological concepts (Stein, Husserl, Merleau-Ponty), various philosophical approaches of embodied intersubjectivity have been conceptualized and described (e.g., Fuchs, 2009; Fuchs & De Jaegher, 2009; Zahavi, 2001). From another point of view, neuroscientist Gallese (2003) also stated that “empathy is deeply grounded in the experience of our lived body” (p. 176). On the other hand, in most neuroscientific conceptualizations, the embodied and kinesthetic dimension of empathy still remains underestimated in our understanding (e.g., de Vignemont & Singer, 2006). Empathy researchers Blair and Blair (2009) explicitly exclude empathy’s kinesthetic dimension in their empathy concept because no data have been available thus far to relate motor empathy to moral or social rule development. Developmental–psychological prerequisites of empathy The development of emotional and cognitive empathic abilities depends on some important developmental–psychological prereq-uisites that can only briefly be outlined here. Self-perception and sense of self From infancy research, it is known that the development of dif-ferent aspects of the sense of self is a crucial basic requirement for the ability to engage in reciprocal interpersonal relationships, as well as for self-perceptive processes such as awareness of cor-poral states and emotions (Stern, 1985/2000). According to Stern (1985/2000), the sense of self is a kind of preverbal organizing subjective experience that is first shaped in the infant’s early inter-actions with the caregiver, the first medium of perception and communication in the young infant being the tactile/motoric mode. In the field of music therapy, Stern’s concept has been diagnosti-cally elaborated upon in order to assess the development of the sense of self and the quality of the relationship to the therapist in patients (Schumacher & Calvet, 2007; Schumacher, Calvet, & Reimer, 2011). In a longitudinal study, it was shown that the qual-ity of the early attachment relationship (measured as the degree of mother-infant synchrony in the first year of life) is a direct predictor of empathic capacity and a moral stance in adolescence (Feldman, 2007a). In the presented intervention, we suggest to foster self-perceptive abilities on the corporal/kinesthetic level, a dimension that often has been found to be disturbed in patients with problems in interpersonal relationships (e.g., in borderline person-ality disorder; Rudolf, 2006). Self-other differentiation The ability to distinguish between the self and other, which is also developed from the earliest interactions with the caregiver and depends on the quality of the attachment relationship (Fonagy, Gergely, Jurist, & Target, 2002), is another crucial aspect of empa-thy and social relationships: In order for empathy to appear in the form of empathic concern and to result in sympathy and prosocial behavior, an awareness is required that it is the other person who is in distress or in need. Otherwise, projecting oneself too much into an aversive situation can lead to empathic overarousal or per-sonal distress in the empathizer without prosocial action (Decety & Lamm, 2006).

(Nonverbal) expressive skills In order to share feelings in social relationships, both recog-nizing the body of another person as an expressive unity and the quality of one's own nonverbal expression (coordination of one's own bodily responses such as emotion-congruent gesture and pos-ture) play an important role throughout life (e.g., Krueger, 2010). Rhythmic interactive processes and mutual imitation between caregiver and child constitute a central role in the development, not only of an implicit sense of self but also of primary intersubjectivity including expressive abilities (e.g., Nadel-Brulfert & Baudonniere, 1982; Trevarthen & Aitken, 2001). We reason that a person's own movement repertoire builds an important foundation for empa-thy because it forms the basis for self-expression as well as for perceiving and interpreting another person's nonverbal behavior. Bodily dimensions of social interactions Within our integrative empathy approach, empathic interac-tions comprise both the perception of the cognitive–emotional– bodily state expressed by the interaction partner and the percep-tion and expression of one's own cognitive–emotional–bodily state (see Fig. 1). The availability of an efficient body schema has been suggested as being necessary not only for recognizing one's own actions, but also for understanding the actions of others (Decety & Sommerville, 2003). In this context, we reason that empathic and intersubjective abilities are fostered by well-developed perceptive and expressive abilities in all of the interconnected levels of body/kinesthesia, emotion, and cognition. In order for reciprocity in the interaction to happen, one has to be able to focus alternately on oneself and the other person in the interaction. Bodily interaction consists of –among other elements – imitative (mimicry), complementary,

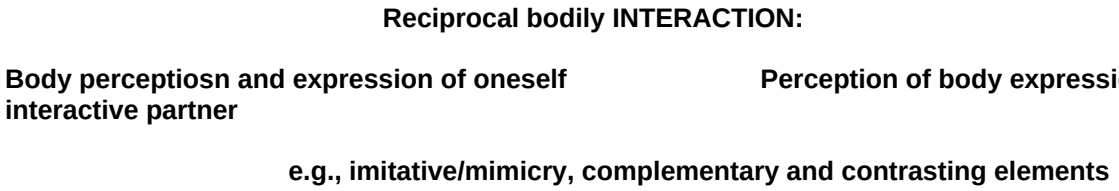


Fig. 1. Bodily dimensions of social interactions.

and contrasting elements in posture and gesture. All of the men-tioned perception and expression processes cover both automatic and conscious aspects. In the proposed dance/movement intervention designed to foster empathy, we propose a strengthening of the outlined pre-requisites of perceptive and expressive abilities by integrating corresponding tasks; nevertheless, the main focus of this article and of the intervention is the interaction process in movement. We suggest that kinesthetic interpersonal experiences, especially in alternation between moving in synchrony with others and mov-ing for oneself while being aware of other people (moving in and out of synchrony), can be important for strengthening a sense of connectedness with others as well as for refining the self-other dif-ferentiation, which are both needed in empathic social interactions. Empathy disorders Examples of psychiatric disorders with relevant problems in empathic processes are, among others, autism spectrum disorders (Dziobek et al., 2008), narcissistic personality disorder (Ritter et al., 2010), borderline personality disorder (Preissler, Dziobek, Ritter, Heekeren, & Roepke, 2010), and social conduct/antisocial personal-ity disorders (Blair &

Blair, 2009; Taubner, Wiswede, Nolte, & Roth, 2010). Different empathy disorders have varying parts of patho-genetic roots (e.g., genetic causes and/or damaging attachment relationships) and can comprise to varying degrees problems in dif-ferent dimensions of empathy: emotional disorders, mentalizing problems, and difficulties in the bodily dimension (body percep-tion, body image, and/or body perceptive/coordinative functions). In our research, we have begun to work with movement and dance elements with people from the autistic spectrum, an approach also suggested in McGarry and Russo's (2011) remarks on mirroring processes. Characteristic problems of people on the autism spectrum include difficulties in the field of social interaction and reciprocal communication and a restricted, stereotyped, and repetitive repertoire of interests and behaviors (DSM-IV, American Psychiatric Association, 2000). Other characteristics in autism are altered sensory perception and processing of acoustic, visual, and other sensory input. Besides difficulties in theory of mind (i.e., cognitive empathy in children and adults with autism spectrum disorders) (Baron-Cohen, Leslie, & Frith, 1985; Baron-Cohen & Wheelwright, 2004), past research has also shown problems with imitation processes (Williams, Whiten, & Singh, 2004) and motor behavior such as fine and gross motor skills and balance in autistic children and adolescents (Freitag, Kleser, Schneider, & von Gontard, 2007; Green et al., 2002; Noterdaeme, Mildenberger, Minow, & Amorosa, 2002). Based on our integrated conceptualization of empathy, we therefore suggest giving autistic people the oppor-tunity to develop and strengthen the kinesthetic component of empathy. Neurobiology of kinesthetic empathy Perception–action coupling and the mirror neuron system The term perception–action coupling refers to the fact that action perception and action production are functionally inter-twined and share common neural structures, with a bidirectional association between a motor pattern and the sensory effects that it produces. Perceiving the action of another person automatically relates to the observer's mirror neuron system, with the effect that in the observer, the same brain areas are being activated as though one is performing the action oneself. In other words, an interindividual mapping of observed movements between the act-ing person and the observer is created (Decety & Meyer, 2008; Semin & Caccippo, 2008)

In the context of emotion processing, the same mechanism has earlier been suggested to explain empathic processes in the sharing of emotional states through observation or imagination with corresponding somatic and autonomic responses in the observer (Preston & de Waal, 2002). Perception-behavior linkages have been repeatedly suggested to play an important role in creating affiliation, rapport, and social cohesion (e.g., Chartrand & Bargh, 1999; Lakin & Chartrand, 2003). The neural correlate for perception–action coupling has been named the mirror neuron system, which has important functions in various imitation and empathic processes (for a review, see Rizzolatti & Craighero, 2004). Mirror neurons are localized mainly in the ventral premotor and parietal cortex, with different asso-ciated brain regions becoming active depending on the type of empathic or imitative processes involved (Iacoboni, 2005; Lamm, Decety, & Singer, 2011; Singer & Lamm, 2009; Singer et al., 2004).

Mirror neuron research has led to concepts of embodied sim-ulation and intercorporeity as central functional mechanisms for empathy (Gallese, 2009). Those concepts point toward a strong neuronal connection between one's own motor experi-ence and intersubjective and empathic processes. The mechanism of embodied simulation implies that during observation of the bodily–emotional state of someone else, the same mirror neuron structures are activated in the observer as in the person observed, whereby an internal simulation of the state observed in the other person is generated with this sharing of body states enabling implicit understanding (Gallese, 2008, 2009). According to Gallese (2009), basic aspects of social cognition are primarily based on motor cognition. He concludes from De Presteer following Merlau- Ponty, that "our own acting body becomes the main source of information about other's behavior" and suggests that embodied simulation has a crucial function for empathy (Gallese, 2009, p. 494). Gallese even proposes that "intersubjectivity is the best con-ceived of as intercorporeity" (p. 486). The role of prior movement and dance experience in action observation The internal/embodied simulation of an observed action evokes the activation of complete action patterns in the mirror neuron system. This process is influenced by a person's previous motor experiences and individual, acquired motor (above visual) representations: The results from two fMRI studies with expert dancers (Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005; Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2006) revealed more activation in mirror neuron circuits while dancers watched their own dance style, or respectively watched movements from their own motor repertoire, compared to watching another dance that they were not experienced in, or respectively watching moves from the opposite gender that they frequently observed but did not perform themselves. In a similar longitudinal fMRI study, Cross, Hamilton, and Grafton (2006) showed an increased mirror neuron response in expert dancers while they observed novel dance sequences they had previously acquired during a 5-week training. Catmur, Walsh, and Heyes (2009) argued for a causal relation between combined sensory/motor experience and modeling of the mirror neuron system: By reviewing the literature on sensorimotor experience, imitation experiments, and fMRIs of mirror neuron areas, and by their own transcranial magnetic stimulation experiments, they strongly support the critical role of sensorimotor experience and previous training in the development of automatic interpersonal imitation processes. It is also important that the probability of repeating a formerly internalized and then observed action is higher than while observing a new action (i.e., it increases with the similarity of motor representations): observing another person's movements activates one's own neuronal action system for the same movement (Knoblich & Sebanz, 2006) and increases the probability of initiating a matched action from one's own motor repertoire (Brass, Bekkering, & Prinz, 2001). These studies show that the neuronal system of internal motor representations can be modified by movement experience and that sensorimotor expertise in a certain movement increases the prob-ability of implementing that movement in a social interaction. In the context of our research, these studies support the approach of fostering empathy and prosocial interactions through the expe-rience and practice of coordinated interactional movement

and dance. Interactional movement and prosocial behavior Much research shows that humans are responsive to move-ments of an interacting partner. Core elements of embodied social cognition that promote bonding and cooperation have been described as synchronization, coordination, and co-regulation of behaviors (Semin & Caccioppo, 2008). Interpersonal coordination as the umbrella term has been defined as the "degree to which the behaviors in an interaction are nonrandom, patterned, or syn-chronized in both timing and form," and consists of two basic types: behavior matching or similarity and interactional synchrony (Bernieri & Rosenthal, 1991, p. 403). With respect to specific inter-actional movement elements, we will now review research on the prosocial and/or empathy-promoting effects of: (1) imitation, (2) synchronous movement, and (3) motoric cooperation conducted in the field of experimental psychology and in contexts of psychother-apy and creative art therapies. Imitation The phenomenon of mimicry or imitation is referred to as behav-ioral matching and happens, more often than not, unintentionally (Lakin, Jefferis, Michelle Cheng, & Chartrand, 2003). Mimicry, as a genuine human tendency in an interaction to unconsciously imitate a partner's gestures, posture, and speech, serves important func-tions in communication, social bonding, and affiliation as a type of "social glue" (Lakin et al., 2003). It has been shown empirically that mimicry in an interview situation leads to stronger affilia-tion and rapport, the likeliness of mimicking increasing with the degree of the (conscious or unconscious) desire to affiliate (Lakin & Chartrand, 2003). Lakin et al. (2003) suggest that mimicking the behaviors of other people could increase prosocial behaviors in a more general way, an argumentation shared by van Baaren, Holland, Kawakami, and van Knippenberg (2004), who showed that study participants who had been mimicked behaved more helpfully and generously toward other people than unmimicked participants. The growing body of research of unconscious imitation together with the strong hints for its evolutionary social bonding power sug-gest that good mimickers have a genuine social advantage because their mimicking leads to liking and inclusion by their correspond-ing social group (e.g., Lakin et al., 2003). It seems therefore obvious that people with empathy deficits, especially those with poor kines-thetic empathic capabilities who also are less skilled mimickers, are at a higher risk of being socially excluded. Synchronous movement Interactional synchrony is mainly defined as interpersonal coor-dination of behaviors in the dimension of time, with similar or even different, but simultaneous movements or change of postures (e.g., Hove & Risen, 2009; Lakens, 2010). Synchronization in a child's ear-liest social interactions plays a pivotal role for the development of affect regulation and later, empathy (for a review on synchroniza-tion processes in parent–infant interaction, see Feldman, 2007b). In empirical psychological research, there is growing evidence for the effects of synchronous movement on affiliation and coop-eration. Basic synchronized activity such as synchronized walking results in more cooperation and personal sacrifice in group eco-nomic exercises (Wiltermuth & Heath, 2009). Hove and Risen (2009) conducted a series of tapping experiments: tapping in syn-chrony with a metronome showed no effect on affiliation toward the non-tapping experimenter, whereas affiliation toward the experimenter increased in the student

probands after they had tapped in synchrony with the experimenter. The authors therefore suggest a causal influence of interpersonal synchrony on affilia-tion. Valdesolo, Ouyang, and De Steno (2010) performed a study involving synchronous whole-body movement when asking par-ticipants to rock in synchrony on rocking chairs, followed by a joint-action task. They found that this kind of synchrony enhanced individuals' perceptual sensitivity to other people's movements and also increased success in the joint-action task, suggesting that the experience of whole-body synchrony promotes cooperative ability. Music and dance Joint rhythm experience in music and dance seems to be an innate human tendency. Eerola, Luck, and Toivianen (2006) showed that children as young as 2–4 years of age rhythmically entrain (assimilate in rhythm) in the form of whole-body dancing move-ments to music pieces of different rhythms, whereby the ability to synchronize increases with age. Within a social context, the tendency to synchronize has been shown to be higher compared to a non-social situation: In the presence of a drumming person, even young children from 2.5 years of age were able to adjust their drumming tempo to a beat outside the range of their spon-taneous motor tempo (Kirschner & Tomasello, 2009). The authors suggest that joint drumming evokes a specific human motivation to synchronize movements during joint rhythmic activity, a phe-nomenon well-known in most people's experience in contexts of music and dance. Wiltermuth and Heath (2009) showed that syn-chrony in collective singing with and without simultaneous moving fosters cooperation and social contributions, a result that might provide one possible explanation for the attraction of engaging in choirs. After drumming with a synchronous drumming part-ner, people showed more spontaneous prosocial helping behavior toward that person (measured as the number of pencils picked up after the drumming partner dropped them, seemingly by accident) than toward an asynchronous drumming partner (Kokal, Engel, Kirschner, & Keysers, 2011). Psychotherapy, music therapy, and dance/movement therapy In their research on dyadic psychotherapies, Ramseyer and Tschacher (2010) quantified the frequency of nonverbal synchrony between therapist and patient by the video analytic method of motion energy analysis. They found that a high quantity of nonverbal synchrony was positively associated with therapeutic relationship quality and long-term therapy outcome, as rated by patients during and after the end of therapy (Ramseyer, 2010; Ramseyer & Tschacher, 2010). In music therapy, synchronous moments (intra- and intersynchronization; Schumacher & Calvet, 2008) have been intensively studied and described with respect to their importance in enhancing interactive abilities, especially in the treatment of autistic children and patients with men-tal retardation (Bergmann, Sappok, Schumacher, & Diefenbacher, 2009; Schumacher, 2004). Naturally, synchronization of whole-body movements to music or to other people (as a conscious as well as unconscious process) constitutes an effective central element in dance/movement therapy. Marian Chace (1951/1993), Chace (1952/1993) has written that moving in rhythmic action in unison results in a feeling of well-being, relaxation, and good fellowship for psychiatric patients, and that joining the dance circle strengthens relationships and helps in the process of resocialization. Early clini-cal observations by therapists in the field of DMT had placed a high emphasis on synchronous movement and

led to the assumption that movement synchrony both facilitates and signifies movement empathy (Fraenkel, 1983). Drawing from her own research on non-verbal behavior in talking dyads, Fraenkel (1983) suggests that echoing processes may be the kinesthetic analogue of reflective techniques applied in verbal psychotherapy. Therapeutic mirroring remains an important although contro-versial technique in dance/movement therapeutic practice. The empathy-fostering potential of the mirroring of the patient by the dance/movement therapist has been discussed and illustrated through examples by Berrol (2006), and has recently been under-scored in a review article by McGarry and Russo (2011), especially as exaggerated or extended mirroring. Nevertheless, attention should be paid to the fact that hyperimitation may lead to aversive reactions in mimicked partners (for psychiatric patients, see Chace, 1953/1993). In a review and discussion chapter by Willke (2007), the significance and dangers of mirroring in DMT are critically elaborated. For reasons discussed there, many dance/movement therapists apply mirroring sparsely, embedded in the therapeu-tic process and, as in Chace's understanding, as only one of many possibilities of empathic reflection (see Sandel, 1993). Nonetheless, we argue in line with McGarry and Russo that mirroring processes support empathic capabilities and extend their idea of a therapy consisting of therapeutic mirroring to our concept of practicing dif-ferent interpersonal coordination tasks in a group setting. We hope that our review of the prosocial effects of synchronous movement in natural, experimental, and therapeutic contexts has made evident the integration of synchronous elements (including mirroring) in the presented group intervention. Motoric cooperation Marsh, Richardson, & Schmidt (2009) apply the term embod-ied cooperation to the coordination of goal-directed actions of two copresent individuals in motion. According to Sebanz, Bekkering, and Knoblich (2006), joint action implies "bodies and minds mov-ing together" and can be defined as "any form of social interaction whereby two or more individuals coordinate their actions in space and time to bring about a change in the environment" (p. 70). In everyday life, social interactions often require motoric cooperation in order to achieve a common goal or as part of empathic responses (e.g., helping another person to move or carry an object). The success of coordinating such a joint goal-directed action depends on different abilities: to share representations, to pre-dict actions, and to integrate predicted effects of one's own and others' actions (Knoblich & Sebanz, 2006; Sebanz et al., 2006). Valdesolo et al. (2010) describe the abilities required for the joint-action task after their synchrony experiments (moving a wooden labyrinth together in order to direct a ball along a certain path) as a dynamic detection and appropriate response to the movement of one's partner. In reviewing studies on joint action, Knoblich and Sebanz (2006) underline that basic action–perception links are cru-cial for many social interactions. We integrate motoric cooperation tasks in our intervention, in order to enable participants to practice the adaptation of their motoric performances in relation to an inter-action partner while pursuing a common goal, as needed in joint social action in everyday life. As an example from psychotherapy, Twemlow, Sacco, and Fonagy (2008) describe that the combined application of a body-oriented approach requiring interpersonal coordination (there: traditional martial arts) and

psychody-namic psychotherapy proved effective in clinical vignettes in the treatment of young people who engage in violent behavior, a con-dition frequently associated with empathy deficits. Research hypotheses On the basis of the role of body and movement in empathic processes, our main research hypothesis is as follows: The prac-tice of interactional movement and dance elements, especially imitation, synchronous movement and motoric cooperation, can foster empathic and prosocial capabilities. In line with Catmur et al. (2009), we argue additionally that it is possible to promote automatic interpersonal coordination processes by correspond-ing sensorimotor training. We suggest that the conscious practice of variations of imitation and mirroring (with both copying and contrasting of movements) has the potential to foster both uncon-scious mimicking behavior and the important ability of self-other differentiation, and to thus contribute to increased social integra-tion, affiliation, and agency. The practice of self-perceptive tasks together with tasks that increase expressive and creative possibil-ities (movement repertoire) additionally fosters the prerequisites needed for coordinated and empathic interactions. Taken together, by increasing and differentiating internal motor representations of coordinated and cooperative actions, we suggest that the perceptive, expressive, and interactive repertoire as a basis for empathic processes can be enhanced. We are aware that the postulated transfer of kinesthetic empathy to other dimensions of empathy and prosocial behavior requires further investigation, all the more because there are important voices in empathy research that separate bodily/kinesthetic aspects and cognitive–emotional dimensions of empathy (Blair & Blair, 2009; de Vignemont & Singer, 2006). We still suggest on the extensive basis of the pre-sented research on perception-action linkage that the proposed transfer is very likely: on the basis of the intertwining of the perception of another person's nonverbal expression and one's own movement/gesture experience and repertoire, we conclude that experiencing oneself in a new, broader range of movement expression can also lead to a refined perception and interpreta-tion of other people's bodily behavior. By promoting kinesthetic empathy skills as practiced in imitation, synchronous movement, and motoric cooperation, we assume that also emotional aspects of empathy that are grounded in bodily perception and expres-sion, and also some cognitive aspects of interaffectivity such as perspective-taking can be influenced in a positive way. Moving in and out of synchrony: introducing a new empathy-fostering intervention Intervention focus and terminology Based on the presented reasoning, we have developed an empathy-fostering movement and dance intervention that we will apply and evaluate in the near future in a controlled study design, starting with adult volunteers on the high-functioning autism spec-trum. The intervention consists of 10 structured units of 90 min per week in a group setting. Pilot sessions in preparation of our study showed the proposed contents of movement and dance to be feasible for both autistic people and typically developed student volunteers with different modifications and structuring of lessons. Even in work with the autistic group, preexisting fears concerning movement and dance decreased, whereas joyfulness and moments of contact and connectedness appeared repeatedly in the move-ment process. We are investigating a core set of movement and

dance elements that we regard as significant for the intention to enhance empathy and interactive capabilities as prerequisites for prosocial behavior: Table 1 Terminology of movement tasks as applied in our intervention. Imitation: One person watches, then replicates a movement of another person as precisely as possible in body, space, and movement quality aspects, with a delay in time (e.g., time needed to watch another person's movement). Imitation may happen in a homolateral or mirror-converted way. One person is active, the other one is receptive at a certain time. Synchronous movement: Two or more people move simultaneously, matched in body, space, time, and quality aspects of movement. Movements may, but do not have to include rhythm or repetition (rhythmic synchrony). Synchronous movement may happen in a homolateral or mirror-converted way (synchronous movement = special case of imitation with additional matching in time). Motoric cooperation: Two or more copresent people in motion cooperate to fulfill a common task/goal or to help each other by acting in a coordinated way. variations of imitation, synchronous movement, and motoric coop-eration. We regard the intervention as a chance for participants to experience interactional movement and dance that can be helpful for social interactions, but we do not intend to mechanically train certain movements. For our research purposes, we would like to introduce a more specific terminology of the three mentioned movement elements, a terminology that differs slightly from the definitions in the previously cited articles on interpersonal coordination in natural settings: In the context of practical movement tasks in our inter-vention, we will use the terms imitation, synchronous movement, and motoric cooperation as follows (see Table 1). Components of movement and dance units On the basis of the dimensions of interpersonal interactions and elements outlined in the theoretical part of the article, we place the main focus for fostering (kinesthetic) empathy on the dimension of reciprocity in bodily/movement interaction. Work to refine the bodily perception and expression of oneself as well as the percep-tion of the interaction partner is also integrated and can be adapted according to the participants' level of those empathy-preceding processes. According to the different dimensions of interaction that we aim to foster – namely, bodily perception, expression, and interaction – we present the following groups and examples of movement and dance elements/tasks to build our empathy-promoting intervention (see Table 2). Of the movement tasks, the interactive elements constitute – with two thirds of the movement time – the unit's main part; body/movement perception and expression tasks together account for about one third. Verbal exchange and feed-back in a circle build the opening and closing frame of each unit. To facilitate a trans-fer of movement experiences into everyday life, a short homework assignment in the form of movement, body perception, or move-ment observation is given at the end of each unit. Structure and content of the intervention In this first conceptualization, the structure and tasks of the intervention's 10 units are especially geared toward the needs of people on the autistic spectrum. Autistic people show some special abilities compared to neurotypical people, e.g., higher gen-eral precision (e.g., higher general precision; Dern, 2008) and good systemizing ability that we try to take advantage of in the move-ment tasks and in a systematic

structure. Therefore, each unit follows the same basic structure: It starts with the opportunity for a short verbal exchange and feedback on the homework. A warm-up session in a circle follows, consisting of a joint movement ritual of increasing complexity. The next part, leading to more interaction, is constituted by tasks designed to refine movement expression and perception in everyday movements like walking: This is real-ized in single and interactive tasks, with a gradual introduction of variations in expression and of contrasting as well as creative ele-ments. The main part of the lesson is constituted by interactive movement and dance elements in increasing complexity: struc-tured imitation and synchronization (of increasing improvisational character, e.g., imitative and mirroring tasks with variations and contrasting elements in different positioning) in dyads or in the group. Motoric cooperation tasks with a common interpersonal goal, consisting of similar or complementary movements (such as in leading and following tasks or the creation of a short, joint chore-ography) comprise another component of the interactive main part. In addition to improvised synchronous movement, a simple joint dance in a specified choreography is learned and realized by par-ticipants over subsequent lessons. The movement part ends with a quiet self-perceptive task to allow for relaxation and self-focusing after the interactive part. Each unit closes with verbal feed-back and exchange of the movement experience by participants in a circle in order to promote as well as to integrate new interactive experiences. For flexible acting in social situations, the (implicit, non-conscious) modulation and adaptation of bodily expression in interactions is of special importance. This automatic modulation and adaptation of movement, posture, and gesture seems to be one of the core problems of people with empathy disorders, espe-cially in autistic people. In the presented intervention, we therefore include not only exact imitation tasks, but also variation and mod-ulation of a given movement by the participants. As an example from one of the later units, a movement observed in the partner is first imitated, followed by a previously practiced variation of the

**Table 2** Composition of dance and movement elements in empathy-fostering intervention (prerequisites and core elements).

| | Dimension | Characteristics | Examples |
|---|---|---|---|
| Prerequisites | (A) Perception | Elements to refine body and movement perception of oneself and other people | Self-perceptive tasks while sitting, standing, or in motion, observing one's partner's and other people's movements in expressive and interactive tasks (B, C) |
| | (B) Expression | Elements to promote bodily expressive and creative possibilities | Basic movements such as variations in walking, variations in and contrasting of movements, creating a small choreography |
| Core elements | (C) Interaction | Interactive elements of interpersonal coordination (1) Imitation | Imitation of one's partner's movements, imitation with modulation/variation (dialogic) |

| | | | |
|---|---|---|---|
| | | (2) Synchronous movement (to other people, to music) | Simultaneous mirroring tasks in dyads and in the group (improvised sequences), |
| | | (3) Motoric cooperation | Leading and following tasks, creating a joint choreography choreographies of simple group dances (specified sequences) |
| | | | |

same movement or by adding another new movement, thereby starting a "movement dialogue." As a general concept of the inter-vention, movement experience and expression by oneself in the presence of others is alternated with moving in coordination with others. With this approach we aim to foster the ability to focus perception alternately on oneself and an interaction partner, as detailed in the theoretical part of this article on bodily dimensions of social interactions. In our conceptualization, joint kinesthetic experiences while moving in and out of synchrony in an apprecia-tive atmosphere and with a mindful attitude are apt to mediate unifying experiences and a sense of togetherness (e.g., in syn-chronous movement) as well as self-other differentiation (e.g., in contrasting tasks). The verbal group reflection of personal experience at the end of each unit is intended to promote a lasting integration of movement experiences in everyday life (Marcher, Jarlnaes, & Münster, 2006). Especially for people with difficulties in bodily self-perception or alienation from their bodies, additional verbalization can facilitate the movement experience in serving as a link between movement and kinesthetic experience (Stark & Lohn, 1993). We hypothesize that the practice of coordinative movement tasks for people with empathy deficits in a group setting has the potential to improve individual expressive variation of movement, empathic abilities and general psychological wellbeing. From a developmental-psychological point of view (for development of the self, see Stern, 1985/2000), interactive movement elements are a rather advanced form of interpersonal engagement and require at least a minimal capacity for reciprocity in the intersubjective rela-tionship, which has to be present beforehand in order to participate in a group intervention. The aim of our intervention is to promote and to further differentiate reciprocal capabilities according to the individual's possibilities, incorporating personal resources.

## Discussion and outlook

By reviewing research on perception-action links and coordi-nated movement elements, we hope to have shown that joint dance and movement have a strong potential to foster empathic and interactive capabilities. We suggest that it is crucial to inte-grate the bodily dimension of perceptive and expressive processes as part of social interactions in diagnostic procedures and treat-ment plans for patients with problems with empathy and social relationships. This is especially relevant for people with problems in nonverbal interaction or with their body image. By enhancing and refining kinesthetic empathy within an integrative concept of empathy, we assume that emotional empathic processes and cog-nitive aspects such as perspective taking can be fostered as well. We are aware that the scientific foundation for this transfer needs to be strengthened by further research in the field of body psychothera-pies and empathy research, to which we hope to contribute in the near

future by application and evaluation of the proposed interven-tion. Although we chose a broad multidisciplinary approach in the outlined conceptualization, there remain some open questions: Nonverbal synchronization processes are probably influenced not only by motoric and kinesthetic aspects, but are also associated with other factors such as personality and attachment style. The impact of those and other factors on empathic interactions needs to be researched further. An additional question remains: How much standardization is possible in an empathy-fostering inter-vention working with movement and dance? In dance/movement therapeutic contexts, the composition of applied methodology is mostly individually centered with a high complexity of different approaches and a diverse set of methods and techniques, a fact that makes research in the field generally difficult (Loew & Tritt, 2006). Apart from the momentary needs of individuals, changing group dynamics have to be addressed as well in order to keep participants motivated. In our study, we will have to meet the challenge–already known in psychotherapy research-of finding a balance between simplification and manualization on the one hand and the impro-visational application of diverse methods and techniques on the other hand. We are planning the first application of our intervention with adults from the autistic spectrum. People with Asperger Syndrome have been shown to be impaired in cognitive empathy, but not to differ from controls in emotional empathy in the form of general emotional arousal and concern (Dziobek et al., 2008). In contrast to the so-called broken mirror hypothesis in autistic spectrum dis-orders, recent research has shown that simple imitation processes show intact functioning, but that relevant problems exist in the modulation and inhibition processes of imitation and higher order integrative processes (Brass, Ruby, & Spengler, 2009; Hamilton, 2008; Hamilton, Brindley, & Frith, 2007). Therefore, for people on the autistic spectrum, emphasis needs to be placed not only on imi-tation, but also on the refinement of the self-other differentiation in a relationship, which we are pursuing by the modulation and variation of movements as part of imitation tasks. We are aware of the fact that creative arts therapies (such as dance/movement therapy and music therapy) with autistic people are mostly realized in an individual setting, all the more when the level of social functioning is low. In order to be able to participate in a group intervention, a certain grade of preexisting interactive abilities is required, a reason for why we start our research with high-functioning autistic people. Nevertheless, for people with lower social functioning, a modified application of the proposed contents is surely possible in a small group or individual setting. Within therapeutical contexts, we see the proposed intervention as an additive to other therapy forms. Especially the impact of a long-term therapeutic relationship cannot be replaced by a short-term, structured intervention. In the future, we plan to investigate feasibility and effects of modified forms of the presented intervention with people with different empathy disorders, also in clinical-therapeutical settings. The program in its core conceptualization is intended to be adapted and modified for different clinical populations, such as patients with antisocial/social conduct disorders and borderline personality disorders. The varying needs of people with different empathy disorders, and the actual level of functioning of the participants can be considered by shifting the emphasis of the different presented components of the program (e.g., varying the emphasis on perceptive, expressive, or interactive tasks) and by inserting additional elements that have proven to work well for specific clinical populations. In adapting dance styles and the selection of music according to the preferences of participants, the intervention can also be tailored to different age groups, including children and teenagers in child and adolescent psychiatry settings. Further research is needed in the

field of body- and art-based psychotherapies in order to design diagnosis-specific interventions. In order to be able to formulate individual indications for dance and movement therapy and to design integrative treatment plans for people with problems in empathy and interpersonal relationships, also a pretherapeutic assessment of empathic abilities and prerequisites of empathy (mentalization level, quality of relationship, bodily perceptive and expressive abilities, etc.) should be developed. With insights from a first evaluation study of the presented intervention that we will undertake in the near future with people on the autistic spectrum (for study design, intervention details and results see future publications), we hope to contribute to some aspects of the development of special dance and movement interventions for people with problems in social interaction in order to foster empathy and interactive abilities.

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Corresponding author. Tel.: +49 30 838 57713/56638; fax: +49 30 838 52887. E-mail addresses: andrea.behrends@fu-berlin.de (A. Behrends), sybmuell@zedat.fu-berlin.de (S. Müller), isabel.dziobek@fu-berlin.de (I. Dziobek).

# Physical performance and behaviour are often prevalent in children with developmental delays. (Get research)

Srinivasan, et al., (2015) noted that "socially embedded movement-based contexts are valuable in promoting imitation/praxis, interpersonal synchrony, and motor performance and should be included within the standard-of-care treatment for children with ASD" (p.1), suggesting that socio-motor skills are essential to education and intervention strategies in ASD.

Srinivasan, S. M., & Bhat, A. N. (2013). A review of "music and movement" therapies for children with autism: embodied interventions for multisystem development. *Frontiers in Integrative Neuroscience*,7(22), 1-15. doi: 10.3389/fnint.2013.00022

„The symptoms of inattentiveness, motor restlessness, and impulsiveness are defined as a group of disorder images which are described in detail in the commonly used classification systems ICD-10 and DSM-IV as attention deficit hyperactivity disorder (ADHD) and are provided with diagnostic criteria."

Diagnosis generally before the age of 6 years, as well as a duration of existence of more than 6 months and the occurrence in more than one situation
Etiology: Causes not yet fully clarified; It is certain that several components are involved in the causation (about 65-90% of the phenotypic variance is attributed to genetic factors)

(Bundesärztekammer)

Bonbright, J., Bradley, K., & Dooling, S. (2013). Evidence: A report on the impact of dance in the K-12 setting. *National Dance Education Organization*. 1-65.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New York: Academic Press.

Group drumming is a recreational music making activity that builds social-emotional skills creating a collectivistic diverse culture, which can 2

eliminate the stigma of therapy (Ho et al., 2011). Ho et al. found significant improvements in social-emotional behaviors in low-income children who engaged in contemporary drum circles and group counseling.

Ho, P., Tsao, J. I., Bloch, L., & Zeltzer, L. K. (2011). The impact of group drumming on social emotional behavior in low-income children. *Evidence-Based Complementary & Alternative Medicine*, 8(1), 1-14.

# PHYSICAL ACTIVITY

**Physical Activity can be defined in the context of energy expenditure as any bodily movement that substantially increases energy expenditure over the resting level., it can be seen as a biocultural behavior: energy is expended in active behaviors that occur in different forms and cultural contexts.** PHYSICAL Activity AND LEARNING • SUMMARY

??Physical Activity (PA) is a good investment because it not only addresses the health needs of individuals with disabilities it will also reduce health disparities and unmet need.

PA has positive influences on concentration, memory and classroom behavior. Data from quasi-experimental studies find support in mechanistic experiments on cognitive function, pointing to a positive relationship between PA and intellectual performance.

Physical education, school physical activity, school sports and academic performance François Trudeau†Email author and Roy J Shephard††Contributed equally International Journal of Behavioral Nutrition and Physical Activity20085:10 DOI: 10.1186/1479-5868-5-10© Trudeau and Shephard; licensee BioMed Central Ltd. 2008Received: 04 September 2007Accepted: 25 February 2008 Published: 25 February 2008

https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-10

Schoolchildren who spent mornings in the classroom and afternoons doing PE were said to perform better academically than children from a control class, but no further details were

given. [7] *Fourestier M: Les expériences scolaires de Vanves. Int Rev Educ. 1962, 8: 81-85. 10.1007/BF01422493.*Google Scholar

A German cross-sectional study (CHILT) compared 12 intervention schools (n = 668) vs. 5 control schools (n = 218), finding that PF was associated with concentration in 6–7 years old children.

Graf C, Koch B, Klippel S, Büttner S, Coburger S, Christ H, Lehmacher W, Bjarnason-Wehrens B, Platen P, Hollamnn W, Predel H-G, Dordel S: Zusammenhänge zwischen köperliche Aktivität und Konzentration in Kindesalter- Eingangsergebnisse des CHILTS-Projecktes [Correlation between physical activities and concentration in children- results of the CHILT project.] https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-10. Deutsche Zeitschrift für Sportmedizin. 2003, 54: 242-246.Google Scholar

https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-10

Chronic exercise creates a favorable environment for LTP by increasing the hippocampal concentrations of neuroprotective factors like brain-derived neurotrophic factor (BDNF) [90] and of other growth factors such as insulin-like growth factor (IGF-1), nerve growth factor, and fibroblast growth factor 2 (FGF-2).

90 Cotman CW, Berchtold NC: Exercise: a behavioral intervention to enhance brain health and plasticity. Trends Neurosci. 2002, 25: 295-301. 10.1016/S0166-2236(02)02143-4.Google Scholar

Acute exercise also normalized certain memory functions, particularly orientation time to novelty and passive avoidance reactions. 92

92Radak Z, Sasvari M, Nyakas C, Kaneko T, Tahara S, Ohno H, Goto S: Single bout of exercise eliminates the immobilization-induced oxidative stress in rat brain. Neurochem Int. 2001, 39: 33-38. 10.1016/S0197-0186(01)00003-1.Google Scholar

Results of some past studies also revealed that PA could have a positive effect in reducing self-stimulators and emotional behaviors in children with ASD (Lang et al., 2010; Loy, 2000; Prupas & Reid, 2001; Valenti, Cerbo, Mased, de Caris, & Sorge, 2010; Yilmaz, Yanardag, Birkan, & Bumin, 2004).

The literature strongly suggests that the academic achievement, physical fitness and health of our children will not be improved by limiting the time allocated to PE instruction, school PA and sports programs.

# SPORT & EXERCISE

**Physical activity (PA) has many health benefits, both physical and psychological. PA has been linked to improved cognitive functioning, superior overall health, and enhanced emotional well-being in populations ganging from school-age children to older adults. ….**

Research utilizing exercise as an intervention suggests a causal relationship between increased physical activity and cognitive ability.
For example, acute bouts of physical activity as well as chronic activity have been associated with improved executive 3 functioning, specifically working memory, multitasking, planning, and inhibitory control. This is evidenced by marked improvements in academic achievement, and performance on cognitive tasks such as the dual visual auditory discrimination and Stroop tasks (Davis, et al., 2007; Hillman, Erickson & Kramer, 2008 ; Sibley & Etnier, 2003; Sibley, Etnier & Le Masurier, 2006; Tomporowski, Davis, Miller & Naglier, 2008)
.
Examination of this relationship at the physiological level has revealed that exercise may improve cognitive functioning by increasing production of brain - derived neurotrophic factor (BDNF). BDNF is a member of the neurotrophin family of growth factors[2] a set of proteins produced in the brain that are beneficial to the development of neurons, supporting the survival and growth of neurons and mediating neuronal connectivity and use - dependent plasticity (Cotman & Berchtold, 2002). The behaviorral and physiological research into the benefits of exercise, taken together, strongly support the theory that physical activity helps improve cognitive functioning.

**??Physical Activity (PA)** is a good investment because it not only addresses the health needs of individuals with disabilities it will also reduce health disparities and unmet need.

PA has positive influences on concentration, memory and classroom behavior. Data from quasi-experimental studies find support in mechanistic experiments on cognitive function, pointing to a positive relationship between PA and intellectual performance.

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The literature strongly suggests that the academic achievement, physical fitness and health of our children will not be improved by limiting the time allocated to PE instruction, school PA and sports programs.

## EMOTIONAL AND BEHAVIORAL DISORDERS PE

Four pupils with emotional and behavioural disorders were directly studied before and after a 10-week PE intervention. Back in class, there was an increase (13.8%, or a little more than 23 minutes) in the amount of time spent focused on the tasks they were supposed to be performing. [81] A 10-week PA intervention in children with learning disabilities improved classroom behaviour and the perception of academic competence was increased. [76] However, a similar outcome was seen in the control group, indicating that there had been no specific effect from the programme.

**76** Bluechardt MH, Shephard RJ: Using an extracurricular physical activity program to enhance social skills. J Learn Disabil. 1995, 28 (3): 160-169.Google Scholar

**81** Medcalf R, Marshall J, Rhoden C: Exploring the relationship between physical education and enhancing behaviour in pupils with emotional behavioural difficulties. Support for Learning. 2006, 21: 169-174. 10.1111/j.1467-9604.2006.00427.x.Google Scholar

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# BDNF & Hippocampal Function Research

**AEROBIC EXERCISE**

**A subcategory of physical activity and can be defined as planned, structured and repetitive physical activity.** PHYSICAL Activity AND LEARNING • SUMMARY

## Aerobic exercise improves hippocampal function and increases BDNF in the serum of young adult males

Éadaoin W. Griffin [a,c], Sinéad Mullally [b,c], Carole Foley [a], Stuart A. Warmington [a,d], Shane M. O'Mara [b,c], Áine M. Kelly [a,c,*]

[a] Department of Physiology, School of Medicine, University of Dublin, Trinity College, Dublin 2, Ireland
[b] School of Psychology, University of Dublin, Trinity College, Dublin 2, Ireland
[c] Trinity College Institute of Neuroscience, University of Dublin, Trinity College, Dublin 2, Ireland
[d] Centre for Physical Activity and Nutrition Research, School of Exercise and Nutrition Sciences, Deakin University, Burwood 3125, Victoria, Australia

Physical activity has been reported to improve cognitive function in humans and rodents, possibly via a brain derived neurotrophic factor (BDNF)-regulated mechanism.

**COGNITIVE FUNCTIONS**

Cognitive functions are related to reception, storage, processing and use of information, including attention, perception, memory and thinking. The term “executive functions” is an established concept used in psychology to refer to co-ordination and control of information processing. Executive functions regulate other cognitive functions essential to human activity, such as memory, attention and thinking. Executive functions are responsible for setting goals, planning operating methods, selecting and controlling the cognitive functions required to achieve the goals, as well as for voluntary control of an individual´s own actions, flexibility of actions as well as evaluation of actions. Such functions are essential in terms of making decisions, solving problems and learning. PHYSICAL Activity AND LEARNING • SUMMARY

Early interventions to enhance their cognitive and social competence have been recommend (Guralnick, 2005; Prupas & Ried, 2001; Ramey & Ramey, 1998). For example, Prupas and Ried found that young children with ASD decrease their mean stereotypy by 51.6% when they have regular exercise for 10 minutes daily. The decrease in stereotypy also helped children adhere to classroom routines at an early age.[3]

Florian, 1994; Wagner, Torgesen & Rashotte,1994). Siegel (1993) reminded us that this debate is not entirely new and, interestingly for the creative arts therapies, that nonverbal tasks are the best means of representing the thinking of very young children.

Adlard, P., Perreau, V., & Cotman, C. (2005). The exercise-induced expression of BDNF within the hippocampus varies across life-span. Neurobiology of Aging, 26 (4), 511 - 520

Neurobiol Aging. 2005 Apr;26(4):511-20.

# The exercise-induced expression of BDNF within the hippocampus varies across life-span.

Adlard PA[1], Perreau VM, Cotman CW.

## Abstract

Voluntary exercise increases hippocampal brain-derived neurotrophic factor (BDNF) expression in young animals. In this investigation we examined the induction of BDNF protein in the hippocampus of young (2 months), late middle-aged (15 months) and old (24 months) animals over 4 weeks of exercise. Average running distances decreased with age, with the old animals also maintaining a constant level of activity over time, whereas the other groups tended to increase their average running distance. All animals demonstrated a biphasic profile of BDNF protein induction, with a significant ($P<0.05$) increase after 1 week of exercise followed by a decrease to near sedentary levels at 2 weeks. After this, BDNF protein levels increased significantly ($P<0.05$), as compared to baseline, primarily only in the young animals. In whole hippocampal homogenates, only particular BDNF mRNA exons were significantly ($P<0.05$) changed as a result of exercise, with the largest induction occurring in young animals. BDNF protein induction may, therefore, not be directly correlated with significant mRNA changes. Exercise may represent a therapeutic tool for disorders which involve a decrease in BDNF.

PMID:
15653179
DOI:
10.1016/j.neurobiolaging.2004.05.006
[PubMed - indexed for MEDLINE]

https://www.ncbi.nlm.nih.gov/pubmed/15653179

## Physical Activity Special Needs

Academic integration of children with various behavioural and developmental problems is a growing trend in industrialized countries. The question arises in terms of their academic achievement. Reviews of exercise programmes for children with learning disabilities [75, 76] have suggested that in order to increase the likelihood of positive outcomes, such programmes should have a low student-instructor ratio. Benefits (with the exception of increased PF) may reflect increased attention toward the participants.

**75** Bluechardt MH, Wiener J, Shephard RJ: Exercise programmes in the treatment of children with learning disabilities. Sports Med. 1995, 19: 55-72. 10.2165/00007256-199519010-00005.Google Scholar
https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-10

**76** Bluechardt MH, Shephard RJ: Using an extracurricular physical activity program to enhance social skills. J Learn Disabil. 1995, 28 (3): 160-169.Google Scholar
https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-10

In children with reading disabilities, a school-based programme of balance and coordination training, throwing, catching, and stretching produced significant improvements in both reading and semantics. [79] Positive changes were maintained for at least 18 months following the programme, reducing the likelihood of a Hawthorne effect. [80]

***79*** *Reynolds D, Nicolson RI, Hambly H: Evaluation of an exercise-based treatment for children with reading difficulties. Dyslexia. 2003, 9: 48-71. 10.1002/dys.235.Google Scholar*

***80*** *Reynolds D, Nicolson RI: Follow-up of an exercise-based treatment for children with reading difficulties. Dyslexia. 2007, 13: 78-96. 10.1002/dys.331.*

**https://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-10**

Four pupils with emotional and behavioural disorders were directly studied before and after a 10-week PE intervention. Back in class, there was an increase (13.8%, or a little more than 23 minutes) in the amount of time spent focused on the tasks they were supposed to be performing. [81] A 10-week PA intervention in children with learning disabilities improved classroom behaviour and the perception of academic competence was increased. [76]

However, a similar outcome was seen in the control group, indicating that there had been no specific effect from the programme.

**76** Bluechardt MH, Shephard RJ: Using an extracurricular physical activity program to enhance social skills. J Learn Disabil. 1995, 28 (3): 160-169.Google Scholar

**81** Medcalf R, Marshall J, Rhoden C: Exploring the relationship between physical education and enhancing behaviour in pupils with emotional behavioural difficulties. Support for Learning. 2006, 21: 169-174. 10.1111/j.1467-9604.2006.00427.x.Google Scholar

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**International Journal of Behavioral Nutrition and Physical Activity**

http://download.springer.com/static/pdf/67/art%253A10.1186%252F1479-5868-5-10.pdf?originUrl=http%3A%2F%2Fijbnpa.biomedcentral.com%2Farticle%2F10.1186%2F1479-5868-5-10&token2=exp=1482766988~acl=%2Fstatic%2Fpdf%2F67%2Fart%25253A10.1186%25252F1479-5868-5-10.pdf*~hmac=3ad4d96171ca261ff2795d5410b1d47d97864794fafea732a18bdb1f0612522b

**According to Dekker et al. (2992**), the most prominent problem behaviors of children wit ID were social problems, attention problems, and aggressive behavior as reported from their parents and teachers.

Bluechard, M. H., & Shepard, R. J. (1995). Using an extracurricular physical activity program to enhance social skills. *Journal of Learning Disabilities, 28*, 160-169.

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See this link for more information on Neural Plasticity and Human Development

http://journals.sagepub.com/doi/abs/10.1111/1467-8721.00010

# A Physical Activity Program Improves Behavior and Cognitive Functions in Children With ADHD: An Exploratory Study

**Claudia Verret1,3, Marie-Claude Guay2,3, Claude Berthiaume3,**

**Phillip Gardiner4, and Louise Béliveau1**

Moderate- to high-intensity physical activity program. In addition to strength and motor skills, it positively influences behaviors and cognitive function such as attention in children with ADHD.

The effects of school PA upon children with learning problems thus remains an open field for research.

Motor disorders, primarily in coordination, such as hand-eye-coordination are one of the integral measures of intellectual disabilities (Lehmkuhle, 2007; Van der Schoot, 1990). Consequently, exercise therapy, with coordinative elements appears to be a vital intervention for these patients.

**Non-Verbal communication.**
In this context drumming, dancing and music are important forms of communication since mankind evolved. **(Research Monkeys)**

Tilannekatsaus tammikuu 2012. Muistiot 2012:1. (”The Brain, Learning Capacity and School. The Perspective of Neural and Cognitive Science.
Status Review January 2012.”) Edited by Teija Kujala, Christina M. Krause, Nina Sajaniemi, Maarit Silvén,
Timo Jaakkola & Kari Nyyssölä.

? Children with disabilities are one of the most marginalized and excluded groups of children, experiencing widespread violations of rights.5

*THIS IS A GOOD STUDY*

***Adapted Physical Activity Quarterly*, 2016, 33, 1 -14**
http://dx.doi.org/10.1123/APAQ.2014-0213


# Effects of an 8-Week Structured Physical Activity Program on Psychosocial Behaviors of Children With Intellectual Disabilities

**Peggy Hiu Nam Choi and Siu Yin Cheung**
Hong Kong Baptist University

The study aimed to investigate the impact of an 8-wk structured physical activity program on selected psychosocial behaviors of children with intellectual disabilities (ID) and to estimate whether generalization occurred. Thirty children (22 boys, 8 girls) with mild ID took part in the study. The ANCOVA results showed a significant difference between the training group and the control group in emotional self-control mean scores, $F(1, 25) = 7.61$, $p = .011$, with the posttest mean score of the training group being better than that of the control group. The correlation analysis showed a medium, positive correlation between the gain scores of emotional self-control in the training context and classroom context of the training group ($r = .41$, $n = 16$, $p = .12$). Hence, generalization appeared to have occurred. ***Keywords**:* intervention, generalization, emotional self-control, social interaction

The psychosocial development of people with intellectual disabilities (ID) varies. Whereas some can be dependable and cooperative, others may have limitation on responding appropriately to social and emotional situations (Auxter, Pyfer, & Huetigg, 2005; Dekker, Koot, Van der Ende, & Verhulst, 2002; Eisenhower, Baker, & Blacher, 2005). According to Dekker et al. (2002), the most prominent problem behaviors of children with ID were social problems, attention problems, and aggressive behavior as reported from their parents and teachers. Krebs (2005) explained this could be due to their difficulties in generalizing information, learning from past experiences, and misinterpreting what is expected of them. This may particularly prevalent in individuals with ID coupled with autism spectrum disorder (ASD; MacKay, Knott, & Dunlop, 2007), and early interventions to enhance their cognitive and social competence have been recommended (Guralnick, 2005; Prupas & Reid, 2001; Ramey & Ramey, 1998). For example, Prupas and Reid found that young children with ASD decrease their mean stereotypy by 51.6% when they have regular exercise for 10 minutes daily. The decrease in stereotypy also helped children adhere to classroom routines at an early age.

Physical educators also hold the view that early interventions are essential to aid social and emotional development in children with ID (Block, 2000; Hellison & Templin, 1991; Krebs, 2005; Wright & Sugden, 1999). Krebs (2005) stated that physical education for students with ID should involve teaching them social

behaviors and the correct emotional responses for everyday situations. Hellison and Templin suggested that the psychosocial behaviors of students can be changed gradually through a structured physical activity (PA) program and can develop self-control, respect for the rights and feelings of others, participation and effort, caring and helping, and self-direction. A similar view was also shared by Wright and Sugden, who stressed that a structured PA program is not only about physical training but should also consider students' cognitive, emotional, and social development. In the process of learning fundamental movements, games, and sports, the participants can learn about positive social behaviors such as taking turns, cooperation, and fair play. Wright and Sugden believed that "learning to move" and "moving to learn" (p. 16) complement each other and are important outcomes of physical education and structured PA programs. In the last decade, researchers have shown more interest in investigating PA in relation to children with ID. Whereas studies on PA-intervention effects in children with ID that focus on their physical outcomes such as cardiovascular capacity (Khalili & Elkins, 2009; Lotan, Isakov, Kessel, & Merrick, 2004), muscle strength, and balance (Golubovic, Maksimovic, Golubovic, & Glumbic, 2012; Gupta & Rao, 2011) are accumulating, research on the effects of PA programs on the psychosocial development of children with ID is sparse. Psychosocial benefits were mostly discussed as a by-product of programs targeted at achieving physical-fitness and sport-skill gains for adults with ID (Andriolo, El Dib, Ramos, Atallah, & da Silva, 2010; Rimmer & Kelly, 1991). In addition, the majority of research that focused on improvements in the psychosocial dimension with PA as a mechanism was mostly conducted in inclusive settings. For example, Brannan, Arick, Fullerton, and Harris (2000) reported that children with ID showed improvements in their self-esteem, self-reliance, and communication skills as a result of their participation in an inclusive camp. Lin (2011) also found that by putting children with and without disability in inclusive physical education classes, the interaction skills of both groups of children were improved as a result of having to communicate with each other to complete learning tasks. A more recent study from Özer et al. (2012) showed that a Special Olympics unified soccer program was effective in increasing social-competence scores and reducing problem behaviors of Special Olympics athletes. In addition, the study also demonstrated positive effect in improving the attitude of the mainstream participants toward people with ID.

Results of some past studies also revealed that PA could have a positive effect in reducing self-stimulators and emotional behaviors in children with ASD (Lang et al., 2010; Loy, 2000; Prupas & Reid, 2001; Valenti, Cerbo, Mased, de Caris, & Sorge, 2010; Yilmaz, Yanardag, Birkan, & Bumin, 2004). However, most of those studies had taken either a case-study or a small-group approach, thus pointing to the need to study intervention effects in larger group settings where group synergy and dynamics might pose a different challenge. Hence, the purpose of this study was to identify the effect of a group-based 8-week structured PA program on selected psychosocial behaviors of emotional self-control and social interaction and to investigate the generalization of those behaviors.

## Conclusion

The findings of this study suggest that a structured Physical Activity (PA)program could have positive effects on psychosocial emotional self-control in children with ID and that generalization appeared to have occurred. Future longitudinal studies are needed to explore the long-term benefits of PA participation and the effectiveness of short PA programs in motivating and sustaining PA participation in children with ID. We recommend that further studies have larger sample sizes and incorporate more schools to examine the interaction of the intervention program with the environment on effecting change in children.

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**Behavioural Brain Research** 226 (2012) 473– 480
Contents lists available at SciVerse Science Direct
Behavioural Brain Research
journal homepage: www.elsevier.com/locate/bbr

# GOOD STUDY

# Exercise, mood and cognitive performance in intellectual disability—A neurophysiological approach

Tobias Vogta,*, Stefan Schneidera, Vera Abelna, Volker Annekenb, Heiko Klaus Strüdera
a Department of Exercise Neuroscience, Institute of Movement and Neurosciences, German Sport University Cologne, Am Sportpark Müngersdorf 6, 50933 Cologne, Germany
b Research Institute for Inclusion through Physical Activity and Sport, Römerstraße 100, 50226 Frechen, Germany

**a r t i c l e i n f o**
Article history:
Received 21 September 2011
Accepted 1 October 2011
Available online 15 October 2011
Keywords: Exercise; Intellectual disability; EEG; LORETA, Mood, Cognition

## a b s t r a c t

While numerous researches addressed the connection between physical exercise, changes in brain cortical activity and its relationship to psycho-physiological processes, most of these neuro-scientific studies were set up for healthy individuals. However, the benefits of exercise, such as well being, physical and cognitive health enhancements are also becoming increasingly important for intellectually disabled individuals.
This study aimed to localize electroencephalographic activity changes in intellectually disabled individuals following a moderate running exercise for 30 min. An increase in cognitive performance and in mood was hypothesized to correlate with a decrease in fronto-temporal brain areas following exercise. Significant changes in cortical current density in frontal brain areas as well as decreases in perceived physical energy could be shown. Overall motivational states (including self-confidence and social acceptance) as well as positive mood increased significantly. However, no changes could be observed for the cognitive tasks following exercise.
With respect to the data provided here there is reason to believe, that a self-selected pace running exercise, enhances self-esteem, coincided with cortical activity changes in fronto-temporal brain areas.

### 1. Introduction

The connection between physical exercises, changes in brain cortical activity [1,2] and its relationship to mood [3–7] and cognition [8–10] has been addressed in several cases recently. The focus of many of these studies was to investigate the different effects of

exercise intensities [11], durations [12] as wellas exercise preference levels [4] on neuropsychological changes. Most of these studies were set up for healthy individuals, such as well-trained athletes, physically active children [5] or elderly people [13,14]. However, the benefits of physical exercise, such as general well being [4], physical [15–17] and cognitive health enhancements [9], are also becoming increasingly important for intellectually disabled individuals, not only because of a general increase in life expectancy [18,19]. Several studies investigated the importance of physical exercise to achieve health benefits for intellectually disabled individuals (for an overview, please see Ref. [20] and more recently Ref. [21]) and it has been shown that physical exercising seems to contribute to well being in intellectually disabled individuals [22]. In addition, there is first evidence that physical exercising improves cognitive processes, for example reaction time [23], and supports social manners, such as friendship [24] in intellectually disabled individuals. However, yet there is rarely any evidence investigating the neuropsychological correlates of physical exercise on intellectually disabled individuals [20,25].

Therefore the aim of our study was to localize changes in brain cortical activity in relation to mood and cognition after a moderate physical exercise intervention in individuals with intellectual disability.

Although the use of electroencephalographical (EEG) analysis in the sport and exercise science has been comparatively rare to date, EEG is a well-established technique, which has been applied in the field of psychology and clinical research for several decades. There is evidence indicating that a general well being as well as cognitive and recreational processes are associated with specific changes in electro cortical activity especially in fronto-temporal regions [3,4,8,9,13,26,27]. These findings support Dietrich's transient hypofrontality hypothesis [28] that suggests a decrease of neural activity in brain cortical regions that are rather inessential to performing the exercise.

Today's technical innovations enable clear EEG recordings, before, after and even during exercise [10,29] and allow, in combination with a localization method (low resolution brain electro magnetic tomography, LORETA), to create mappings of the recorded brain cortical changes [3,30].

In this study we hypothesized that (1) moderate 30 min running of intellectually disabled individuals [20,21,31] would lead to a decrease in cortical activation after exercising, particularly in fronto-temporal brain regions. Based on previous results addressing the connection of physical exercise, mood and cognition [7,9,10], (2) an increase in cognitive performance that is accompanied by an increase in mood is hypothesized to correlate with the expected changes in fronto-temporal areas.

To minimize distraction within the participating intellectually disabled individuals, we chose a field setting and tried to put as few limitations as possible on their running activities [4,13].

## 5. Conclusion

The benefits of physical exercise on mood and cognitive performance have been investigated in several neuropsychological studies [5,7,9]. With respect to the data provided here it could be assumed, that a moderate self-selected pace running exercise for 30 min, enhances self-esteem, coincided with cortical activity changes in fronto-temporal brain areas. However, no effects on cognitive performance were observed.

Following this neuropsychological approach, there is a need for future studies, evaluating the specific needs to enhance mood in intellectually disabled individuals. In addition, further investigations of neurocognitive processes should take the clinical picture's diversity of intellectual disabilities into account, if possible in more homogeneous participants.

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# RHYTHM BEAT KEEPING

## GOOD STUDY

Accurate beat-keeping involves synchronization between the parts of the brain responsible for hearing as well as movement and plays a significant role in reading and language skills.

Because hearing sounds of speech and associating them with the letters comprising written words is crucial to learning to read, the Northwestern researchers reasoned that the association between reading and beat synchronization likely has a common basis in the auditory system.  (Musicians have highly consistent auditory-neural response)
Provided by Northwestern University

**A study in *The Journal of Neuroscience* by Dr. Nina Kraus shows a relationship between neural response consistency and ability to keep a beat. Dr. Kraus' lab, shown here, investigates the neurobiology underlying speech, music, and learning. Credit: Dr. Nina Kraus**

# The importance of keeping a beat: Researchers link ability to keep a beat to reading, language skills

17 September 2013 Medical Press http://medicalxpress.com/news/2013-09-importance-link-ability-language-skills.html

Researchers in Germany used positron emission tomography (PET) to identify distinct cortico-cerebellar networks activated by rhythmic motor synchronization and bimanual coordination tasks.17

*17. Thaut MH, Stephan KM, Wunderlih G, Schicks W, Tellmann L, Herzog H, McIntosh GC, Seitz RJ, Homberg V. Distinct cortico-cerebellar activations in rhythmic auditory motor synchronization. Cortex (2009); 45: 44-53. Available at www.sciencedirect.com.*

Similar studies have examined various aspects of temporal control and motor skills or cortico-cerebellar loops using imaging technologies like PET, fMRI, and magnetic lectroencephalography.18-19 These studies are demonstrating the link between cognition and movement. They repeatedly show that physical tasks activate/strengthen executive pathways and vice versa.

*18. Pollok B, Butz M, Gross J, Schnitzler A. Intercerebellar coupling contributes to bimanual coordination. J Cogn Neurosci. 2007;19(4):704-719.*

*19. Pollok B, Gross J, Mueller K, Aschersleben G, Schnitzler A. The cerebral oscillatory network*
*associated with auditorily paced finger movements. Neuroimage. 2005;24:646-55.*

positively change functional hand skill in a pediatric population as measured by the JTTHF; 2) a short regimen is likely to significantly, positively change a participant's internal timing abilities; and 3) parents report statistically significant changes in a variety of their children's behaviors after IM training

The greatest areas of change were coordination, speech fluency, and keeping a beat. These are consistent with previous studies.7,9,10,12,13, 30

*7. Lotze M, Montoya P, Erb M, Hulsmann E, Flor H, Klose U, et al. Activation of cortical and cerebellar motor areas during executed and imagined hand movements: an fMRI study. J Cogn Neurosci.1999;11:491-501.*

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## RHYTHM FOR REHABILITATION

Walking training, an important part of rehabilitation, can benefit from sound rhythms. During rehabilitation an auditory or visual rhythm can improve the gait or elicit changes in step. In collaboration with partners from rehabilitation centres and industry this has led to a new rehabilitation treadmill, the C-Mill. Various nursing homes and rehabilitation centres in the Netherlands and other countries are already using this rehabilitation treadmill together with external rhythms to make walking rehabilitation more functional, challenging and fun.
http://medicalxpress.com/news/2013-08-running-and-rehabilitation-improved-with.html
Journal Reference - PLoS ONE Medical Press

# Walking to the beat could help patients with Parkinson's disease

**September 20, 2012**

Walking to a beat could be useful for patients needing rehabilitation, according to a University of Pittsburgh study. The findings, highlighted in the August issue of *PLOS One*, demonstrate that researchers should further investigate the potential of auditory, visual, and tactile cues in the rehabilitation of patients suffering from illnesses like Parkinson's Disease—a brain disorder leading to shaking (tremors) and difficulty walking.

*More research is needed if we want to talk about this*

# MUSIC

Human behaviour such as speech and movement requires precise coordination and timing. In a study published online today in the *Journal of Neuroscience*, the researchers - Sundeep Teki, Dr Manon Grube, Dr Sukhbinder Kumar and Professor Timothy Griffiths, a Welcome Trust Senior Research Fellow - presented sequences of click sounds to 18 volunteers in a magnetic resonance imaging scanner.

http://medicalxpress.com/news/2013-09-importance-link-ability-language-skills.html

**Accurate beat-keeping involves synchronization between the parts of the brain responsible for hearing as well as movement and plays a significant role in reading and language skills.**

Because hearing sounds of speech and associating them with the letters comprising written words is crucial to learning to read, the Northwestern researchers reasoned that the association between reading and beat synchronization likely has a common basis in the auditory system. (Musicians have highly consistent auditory-neural response)
Provided by Northwestern University

**APA citation**: The importance of keeping a beat: Researchers link ability to keep a beat to reading, language skills (2013, September 17) retrieved 26 March 2016 from http://medicalxpress.com/news/2013-09-importance-link-ability-language-skills.html

**A study in *The Journal of Neuroscience* by Dr. Nina Kraus shows a relationship between neural response consistency and ability to keep a beat. Dr. Kraus' lab, shown here, investigates the neurobiology underlying speech, music, and learning. Credit: Dr. Nina Kraus**

The importance of keeping a beat: Researchers link ability to keep a beat to reading, language skills 17 September 2013 Medical Press http://medicalxpress.com/news/2013-09-importance-link-ability-language-skills.html

# A review of“music and movement” therapies for children with autism: embodied interventions for multisystem development

***Sudha M.Srinivasan1,2 and Anjana N.Bhat1,2,3**** *1 DepartmentofKinesiology,NeagSchoolofEducation,UniversityofConnecticut,Storrs,CT,USA 2 CenterforHealth,Intervention,andPrevention,UniversityofConnecticut,Storrs,CT,USA 3 CenterfortheEcologicalStudyofPerceptionandAction,UniversityofConnecticut,Storrs,CT,USA*

**EFFECT OF MUSICAL EXPERIENCES ON THE REFINEMENT OF GROSS AND FINE MOTOR SKILLS**

Whole body rhythmic actions such as clapping, marching, or walking to music provide significant opportunities to facilitate gross motor skills.

**MUSICAL EXPERIENCES, PERCEPTION-ACTION LINKAGES, AND BRAIN DEVELOPMENT**

Multiple brain regions, including motor, perceptual, language, and social-emotional systems are stimulated duringmusical expe-riences due to their multimodal, multisystem nature.

**Music and language systems also share common neural substrates.**

Specifically, the Heschl’s gyrus, planum temporale, secondary auditory cortex, and the corpus callosum are all involved in both music and language processing (Meyer et al., 2002).

**CONCLUSIONS**

In this review, we offered substantial evidence for the multisys-tem effects of musical experiences in children with ASDs, healthy individuals, as well as other pediatric neurological populations. We believe that novel, embodied rhythm-based, multisystem interventions grounded in singing, music-making, joint action, and social synchrony can be used to alleviate the core social communication deficits and perceptuo-motor and behavioral comorbidities of children with ASDs. Current evidence for the efficacy of music therapies in children with ASDs comes from a handful of studies that lack systematic study designs, assessments, and treatment protocols. There is an urgent need for systematic research in this field. Our research team has developed an intense, 8-week, novel, embodied musical intervention that will be tested within a pilot, randomized controlled trial to assess its effects on the multisystem performance of children with ASDs. If our hypotheses are upheld, we will be providing objective evidence to support the use of rhythm-based, music and movement inter-vention for children with ASDs. Future research should extend this work by examining multisystem effects of music therapies through larger clinical trials using larger sample sizes.

# Interactive Metronome (IM) training

## A Retrospective Outcomes Study Examining the Effect of Interactive Metronome on Hand Function

Tracy M. Shank, MS, OTR/L, CHT, Outpatient Therapy Services, Wendy Harron, OTR/L, Outpatient Therapy Services

**Please cite this article as: Shank TM, Harron W, A Retrospective Outcomes Study Examining the Effect of Interactive Metronome on Hand Function, Journal of Hand Therapy (2015), doi: 10.1016/j.jht.2015.06.003.**

This retrospective study examined the efficacy of IM training on improving timing skills, hand function, and parental reports of self-regulatory behaviors. Later; IM as a sports-enhancement modality, marketing widely to occupational and physical therapists. Shortly after, the company published research suggesting that IM training improved academic and behavioral weaknesses in children with ADD/ADHD.9

*8 Bartscherer ML, Dole RL. Interactive Metronome training for a 9 year old boy with attention and motor coordination difficulties. Physiother Theory Pract. 2005;21(4):257-69.*

Improvements in language processing, reading skills, listening skills, aggression, and attention were demonstrated.10-12

*10. Schaffer R, Jacokes E, Cassily J Greenspan S Tuchman R, Stemmer PJ. Effect of Interactive Metronome training on children with ADHD.* ***Am J OccupTherapy****. 2001;2:155-62.*

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*12. Kuhlman K, Schweinhart LJ. Timing in child development. (1999). Ypsilanti, MI: High/Scope Educational Research Foundation.*

**Researchers in Germany used positron emission tomography (PET) to identify distinct cortico-cerebellar networks activated by rhythmic motor synchronization and bimanual coordination tasks.17**

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positively change functional hand skill in a pediatric population as measured by the JTTHF; 2) a short regimen is likely to significantly, positively change a participant's internal timing abilities; and 3) parents report statistically significant changes in a variety of their children's behaviors after IM training

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# A Retrospective Outcomes Study Examining the Effect of Interactive Metronome on Hand Function

Author: Tracy M. Shank, MS, OTR/L, CHT
Outpatient Therapy Services
Nemours / A. I. duPont Hospital for Children
1600 Rockland Road, Wilmington, DE 19803 United States
tracyshank28@gmail.com
Author: Wendy Harron, OTR/L
Outpatient Therapy Services
Nemours / A. I. DuPont Hospital for Children
1600 Rockland Road, Wilmington, DE 19803 United States
Corresponding author: Tracy M. Shank, MS, OTR/L, CHT, Outpatient Therapy Services, Nemours/ A I DuPont Hospital for Children, 1600 Rockland Road, Wilmington, DE 19803, United States
tracyshank28@gmail.com
610-518-0469

## Abstract:

Interactive Metronome (IM, The Interactive Metronome Company, Sunrise, Florida, USA) is a computer based modality marketed to rehabilitation professionals who want to improve outcomes in areas of coordination, motor skills, self-regulation behaviors, and cognitive skills. This retrospective study examined the efficacy of IM training on improving timing skills, hand function, and parental report of self-regulatory behaviors. Forty eight children with mixed motor and cognitive diagnoses completed an average of 14 one-hour training sessions over an average of 8.5 weeks in an outpatient setting. Each child was assessed before and after training with the **Interactive Metronome** Long Form Assessment, the Jebsen Taylor Test of Hand Function, and a parent questionnaire. All three measures improved with statistical significance despite participants having no direct skill training. These results suggest an intimate relationship between cognition and motor skills that has potential therapeutic value.

**Level 4, Retrospective Case Series**
Keywords: Interactive Metronome, Hand Function, Pediatric, Outcome Study, Cognition

# The Validation of the Interactive Metronome: A Pilot Study Prior to Implementation for Post Deployment Service Members

iMedPub Journals
http://www.imedpub.com

JOURNAL OF NEUROLOGY AND NEUROSCIENCE
ISSN 2171-6625
**2015**
Vol. 6 No. 2:7

**Leonard Trujillo* and Jane Painter-Patton**
Department of Occupational Therapy, College of Allied Health Sciences, East Carolina University, Greenville, NC, USA
**Corresponding author:** Leonard Trujillo

## Abstract
The purpose of this study was to validate the protocols created for the Interactive Metronome TM (IM) used in conjunction with the TRX® System for returning post deployment service members diagnosed with mild traumatic brain and/or Post-Traumatic Stress Disorder. This was done using a pilot population similar in age and physical status as active duty military, but within a college setting. The pre-established protocols were pilot tested on two male and two female participants. The data collected was from the IM Long Form, Nine Hole Peg Test, Canadian Occupational Performance Model and the Test of Everyday Attention. In a comparative analysis of pre- and post- status it was determined that the IM along with TRX® system would potentially benefit returning post deployment service members using this series of treatment interventions.

**Keywords:** Interactive metronome protocol development; Validating assessments; Innovative neurological intervention; Interactive metronome; Post traumatice stress interventions

## Instrumentation: The Interactive Metronome™ (IM)
The Interactive Metronome™ is a treatment tool that has been shown to improve neurological functions of motor planning and sequencing [17]. According to IM, it has been shown to improve attention, concentration, cognitive speed, memory, and a variety of other skills. Additionally, it may help clients with the diagnoses of attention deficit hyperactivity disorder, cerebral palsy, epilepsy, traumatic brain injury, and more [17]. The IM was selected for this pilot study because of the promising neurological effects it has had in past

studies regarding attention and concentration. The IM is a computerized software system with special hand and foot switches that provide a synchronized, rhythmic reoccurring tone that the user in turn, attempts to hit the hand and/or foot switch at the same time as the synchronized tone. The software provides the user instant feedback of the milliseconds one is either slower than the reoccurring sound or faster than the rhythm pace presented. It provides both visual and auditory feedback to allow the user to adjust accordingly. Research with animals has shown that after brain injuries occur, there are structural changes that take place in the brain [22]. This research suggests that strategies that enhance plasticity in the motor cortex can lead to gains in functional abilities. The IM operates on the concept of neural plasticity and may be a strategy that allows the brain to build and strengthen connections through the repetitive exercises regardless of the premorbid status of the user.

The IM, particularly the home system, is convenient and can be done in the home on a client's own time. Furthermore, although it utilizes a bottom-up design, the benefits gained from the IM may provide positive carry over into other areas of occupation. In this study the IM Short Form and IM Long Form evaluations were used to compare changes and anticipated improvements in using the IM. The IM Short Form is a short brief evaluation intended to provide the IM Provider a brief insight to the possible status of the client just prior to starting the session. The IM Long Form is an assessment that uses the 14 different IM tasks and establishes a baseline. It is used at the onset, and again at the conclusion of the protocol series being followed providing a comparison between the before and after scores. It records the timing and number of "Super Right On" hits (perfect score hits) and estimates percentages of number of hits that fall within the desired areas [17].

## Summary and Conclusion

Though the results of this pilot study provided moderate areas of significance, the observed changes demonstrate the positive effects of the designed and implemented Interactive Metronome and TRX® protocol series. The most pertinent information can be seen in the areas of attention and life satisfaction. The intervention sessions of the designed protocol series affected attention skills and life satisfaction of the normal, young adult participants of the pilot study population. Change was observed using a variety of evaluation tools. The Test of Everyday Attention and the Canadian Occupational Performance Measure showed improvements in attention skills and life satisfaction of the four participants. It may be concluded that the protocols series using the IM and TRX® is effective at producing positive change in such areas, and may be applied to post-deployed military personnel individuals with mild traumatic brains injuries and/or posttraumatic stress disorder symptoms.

#17 IM Certification Provider Training Manual, Interactive Metronome TM (2009). *#22 Nudo RJ (1999) Recovery after damage to motor cortical areas. Curr Opin Neurobiol 9: 740-747.*

***Carrie find research #22***

GOOD STUDY

# Getting back on the beat: links between auditory–motor integration and precise auditory processing at fast time scales

Adam Tierney[1,2,3,*] and Nina Kraus[1,2,3]
[1]Auditory Neuroscience Laboratory, Institute for Neuroscience, Department of Communication Sciences, Northwestern
University, 2240 Campus Drive, Evanston, IL 60208, USA
[2]Department of Neurobiology and Physiology, Northwestern University, 2240 Campus Drive, Evanston, IL 60208, USA
[3]Department of Otolaryngology, Northwestern University, 2240 Campus Drive, Evanston, IL 60208, USA
Keywords: adaptation, auditory, motor, synchronization
Edited by Guillaume Rousselet
Received 27 April 2015, revised 21 December 2015, accepted 4 January 2016

## Abstract

The auditory system is unique in its ability to precisely detect the timing of perceptual events and use this information to update motor plans, a skill that is crucial for language. However, the characteristics of the auditory system that enable this temporal precision are only beginning to be understood. Previous work has shown that participants who can tap consistently to a metronome have neural responses to sound with greater phase coherence from trial to trial. We hypothesized that this relationship is driven by a link between the updating of motor output by auditory feedback and neural precision. Moreover, we hypothesized that neural phase coherence at both fast time scales (reflecting subcortical processing) and slow time scales (reflecting cortical processing) would be linked to auditory–motor timing integration. To test these hypotheses, we asked participants to synchronize to a pacing stimulus, and then changed either the tempo or the timing of the stimulus to assess whether they could rapidly adapt. Participants who could rapidly and accurately resume synchronization had neural responses to sound with greater phase coherence. However, this precise timing was limited to the time scale of 10 ms (100 Hz) or faster; neural phase coherence at slower time scales was unrelated to performance on this task. Auditory–motor adaptation therefore specifically depends upon consistent auditory processing at fast, but not slow, time scales.

## Discussion

As predicted, participants who were better able to rapidly adapt to a changing metronome tempo or more quickly resynchronized to a beat after a timing shift had neural responses with greater phase coherence from trial to trial. However, in contrast to our predictions, this greater neural precision was limited to the higher frequencies that make up the subcortical

frequency-following response (90–410 Hz, corresponding to time scales of 2.5–11 ms). Good and poor adapters did not differ in neural precision at the lower frequencies that characterize the cortical evoked response (5–10 Hz, or 100–200 ms).
Humans can accurately synchronize to sound by rapidly and precisely adapting to errors that emerge from transient fluctuations in stimulus input and motor output (Repp, 2000; Madison & Merker, 2004). However, not everyone is equally skilled at this auditory–motor integration, and we predicted that the phase coherence of neural sound processing across slow and fast time scales would help to determine error correction skill. As predicted, we found that participants whose frequency-following responses to sound showed greater phase coherence from trial to trial were better able to adapt to timing shifts while synchronizing. However, in contrast to our predictions, we found that the phase coherence of the lower-frequency cortical response was unrelated to auditory–motor adaptation skills.

These results suggest that auditory neural precision on the time scale of ≥100 Hz (periods of ≤10 ms) that characterizes the frequency-following response is crucial for accurate auditory–motor temporal integration. Auditory neural precision on the slower scale of 5–10 Hz (100–200 ms) that characterizes the cortical response, however, does not seem to underlie accurate auditory–motor adaptation.

It may instead be more important for tasks that require the integration of auditory information over time, such as extraction of the beat from a complex stimulus or encoding a sequence of durations into memory, a prediction that could be investigated by future work. We previously reported (Tierney & Kraus, 2013) that variability during beat synchronization is lower in subjects with more precise frequency-following responses. However, beat synchronization is a complex task, and synchronization variability can therefore reflect different sources of variance, including motor variability, timekeeper variability, and the use of auditory feedback to correct transient increases in the asynchrony between movement and sound. Here, we present evidence that temporal precision of the frequency-following response is vital for auditory–motor timing integration. The primary neural generator of the frequency-following response (Chandrasekaran & Kraus, 2010) is the inferior colliculus (IC), a region that may play a crucial role in the auditory–motor error correction processes that make synchronization possible. The IC is a neural hub, receiving afferent input from peripheral auditory structures (Kudo & Niimi, 1980; Coleman & Clerici, 1987) and efferent input from cortical regions (Bajo et al., 2010). The IC is also capable of precisely phase-locking to high-frequency auditory input (Liu et al., 2006), a characteristic that causes it to be the primary generator of the frequency-following response (Warrier et al., 2011). Moreover, the IC connects directly to the cerebellum, bypassing the auditory cortex (Mower et al., 1979; Hashikawa, 1983; Saint Marie, 1996). The cerebellum updates motor behaviour by comparing expected with actual feedback (Wolpert et al., 1998), and is involved in both auditory–motor synchronization (Molinari et al., 2007; Bijsterbosch et al., 2011) and perceptual timing (Lee et al., 2007). The cerebellum, in turn, connects to the basal ganglia,

the proposed location of a beat-based timing system (Grahn and Brett, 2007, Teki et al. 2011, Bartolo et al., 2014) that has been linked to a deficit in tempo adaptation (Schwartze et al. 2011). The IC's temporal precision, integrative role and direct connection to subcortical motor structures therefore make it ideal for communicating auditory timing information to motor regions (Molinari et al., 2005; Warren et al., 2005; Malcolm et al., 2008), a process that is crucial for auditory–motor integration. Our results suggest that fine temporal precision in the IC is important for accurate auditory–motor integration. Thus, temporal precision in the auditory midbrain may be a crucial gatekeeper that helps to determine individual differences in auditory–motor timing ability. On the other hand, the lack of relationships between phase-locking at slower time scales (100–200 ms) and adaptation to timing perturbation during synchronization suggests that low-frequency cortical temporal precision is not a crucial factor driving precise auditory– motor integration. This is surprising, given that cells in the premotor cortex are tuned to duration and serial order (Merchant et al., 2013; Crowe et al. 2014), that the auditory cortex and motor/ premotor cortex are functionally connected during synchronization tasks (Pollok et al., 2003; Chen et al., 2006, 2008; Krause et al. 2010), and that phase-locking of slow cortical oscillations plays a role in the tracking of rhythmic information (Nozaradan et al., 2011, 2012; Tierney & Kraus, 2014). It is possible that the auditory cortex is responsible for integrating timing information over a longer time scale, on the order of hundreds of milliseconds or more, which would be more important for tasks such as remembering rhythmic sequences or predicting the timing of future rhythmic events (Merchant et al., 2015) than for synchronization. Thus, although the auditory cortex and premotor cortex do interact during synchronization, slow auditory phase-locking may not be a bottleneck for synchronization skill, because beat synchronization does not rely on integration of information across time periods longer than tens of milliseconds. Alternatively, it could be that other cortical functions besides low-frequency phase-locking are important for error correction in synchronization. Perhaps, for example, subcortical high-frequency phase coherence can affect the temporal consistency of the middle latency response, which then influences synchronization via connections to the premotor cortex. Another possible explanation for the lack of a connection between low-frequency neural phase coherence and synchronization adaptation is that the sounds to which participants were synchronizing were characterized by very rapid amplitude onsets. For sounds with gradually ramping onsets, amplitude rise time helps to determine perceived onset time (Caclin et al., 2005). As tracking of the amplitude envelope is tied to phase-locking of slow cortical oscillations (Luo & Poeppel, 2007; Abrams et al., 2008; Poeppel et al., 2008; Abrams et al., 2009; Goswami, 2011), it could be that synchronization to stimuli with less abrupt onsets (such as speech stimuli) depends more on slow-time-scale neural consistency. For stimuli instead be able to rely on the robust onset responses produced by subcortical auditory regions. We found that inter-trial phase-locking of the frequency-following response and phase-locking of the lower-frequency cortical auditory evoked response were not correlated. This suggests that individual variations in phase coherence within the auditory system cannot be accounted for

via a unitary mechanism. Instead, cortical and subcortical precision are decoupled, such that a given participant could have a precise low-frequency cortical response but an imprecise frequency- following response (or vice versa). Thus, a promising avenue for future research would be to investigate the mechanisms that determine neural precision at high and slow rates. Although synchronization to an auditory beat is a skill that humans easily master, it is surprisingly rare in the animal kingdom, having been reported in only a handful of species to date (Patel et al., 2009; Hasegawa et al., 2011). Moreover, at present it has not been demonstrated in any other primate, despite at least one extensive attempt to teach the skill to rhesus monkeys (Zarco et al., 2009). The majority of the species that have been shown to synchronize, including the African grey parrot and the sulphur-crested cockatoo, are capable of vocal learning (Patel et al., 2009; Schachner et al., 2009; although see Cook et al., 2013), suggesting that there may be overlap between the auditory–motor connections that make vocal learning possible and those crucial for synchronization. Speculation to date regarding the necessary preconditions for synchronization has largely focused on connections between auditory cortical areas, premotor regions, and the basal ganglia (Patel et al., 2009; Merchant & Honing, 2014; Patel & Iversen, 2014). However, our finding that high-frequency auditory neural precision (>100 Hz, corresponding to time scales of ≤10 ms) is linked to synchronization skill suggests that it may be fruitful to examine structural and functional interactions between subcortical auditory regions and motor areas as well. For example, strengthening of the direct connection between the auditory midbrain and cerebellum could enable the rapid, precise auditory–motor integration necessary for both vocal learning and synchronization. Conversely, a lack of a strong connection between subcortical auditory and motor areas in species that cannot perform vocal learning could explain the lack of a benefit for auditory vs. visual stimuli for rhesus monkeys performing perceptual– motor synchronization tasks (Zarco et al., 2009; Kraus & White-Schwoch, 2015).

Our finding that auditory neural precision at a fast time scale enables rapid adaptation during synchronization adds to the growing evidence that precision at fast time scales is crucial for auditory perception. Not only is neural precision linked to synchronization consistency (Tierney & Kraus, 2013) and adaptation, but children with more consistent frequency-following responses also perform better at word-reading tasks (Hornickel & Kraus, 2013). This suggests that a precise neural response enables extraction of a stable percept of the timing of sound and reliable categorization of speech sounds, whereas a less precise response interferes with these processes.

Given that auditory neural precision appears to be important for the development of language skills and a gatekeeper for synchronization ability, it is an intriguing question whether synchronization training could enhance neural precision, potentially boosting language skills. Indirect support for this view is provided by studies of musical training, which have revealed that musical training tracks with enhanced consistency of neural responses to sound (Parbery-Clark et al., 2012; Skoe & Kraus, 2013) and enhanced language

skills (Moreno et al., 2009; Parbery-Clar et al., 2009; Kolinsky et al., 2009; Bhide et al., 2013; François et al., 2013; Zuk et al., 2013; Slater et al., 2014). Moreover, short-term auditory training has been shown to enhance both response consistency and language skills (Hornickel et al., 2012). Given that synchronization training via computer-based training programs would be cost-effective and efficient, examining the effects of synchronization training on neural function and language skill is a promising avenue for the future.

Contents lists available at ScienceDirect

# Brain & Language

journal homepage: www.elsevier.com/locate/b&l


# Incorporation of feedback during beat synchronization is an index of neural maturation and reading skills


Kali Woodruff Carr a,b, Ahren B. Fitzroy a,b,1, Adam Tierney a,b,2, Travis White-Schwoch a,b, Nina Kraus a,b,c,d,⇑

a Auditory Neuroscience Laboratory, Northwestern University, 2240 Campus Drive, Evanston, IL 60208, USA

b Department of Communication Sciences, Northwestern University, 2240 Campus Drive, Evanston, IL 60208, USA

c Department of Neurobiology & Physiology, Northwestern University, 2205 Tech Drive, Evanston, IL 60208, USA

d Department of Otolaryngology, Northwestern University, 675 North St Clair, Chicago, IL, USA



## Keywords:

Sensorimotor synchronization
Feedback
Reading
CAEP
Development
Gamma



## a b s t r a c t

Speech communication involves integration and coordination of sensory perception and motor production, requiring precise temporal coupling. **Beat synchronization, the coordination of movement with a pacing sound, can be used as an index of this sensorimotor timing**. We assessed adolescents' synchronization and capacity to correct asynchronies when given online visual feedback. Variability of synchronization while receiving feedback predicted phonological memory and reading sub-skills, as well as maturation of cortical auditory processing; less variable synchronization during the presence of feedback tracked with maturation of cortical processing of sound onsets and resting gamma activity. We suggest the ability to incorporate feedback during synchronization is an index of intentional, multimodal timing based integration in the maturing adolescent brain. Precision of temporal coding across modalities is important for speech processing and literacy skills that rely on dynamic interactions with sound. Synchronization employing feedback may prove useful as a remedial strategy for individuals who struggle with timing-based language learning impairments.

## 4. Discussion

**This work reinforces evidence of a relationship between the ability to synchronize to a beat and cognitive and language skills** (Corriveau & Goswami, 2009; David, Wade-Woolley, Kirby, & Smithrim, 2007; Flaugnacco et al., 2014; Thomson, Fryer, Maltby, & Goswami, 2006; Thomson & Goswami, 2008; Woodruff Carr et al., 2014) that extends into adolescence (Tierney & Kraus, 2013b).

Here, we extend this research to employ an online feedback task, revealing that synchronization variability, but not asynchrony, while correcting timing using explicit feedback also relates to working memory and phonological awareness, and uniquely relates to phonological memory, reading subskills, and reading fluency. Adolescents who synchronized less variably also scored higher on these reading-related tests. Additionally, more mature auditory processing of speech onsets and intrinsic oscillatory gamma activity related selectively to the variability of synchronization during the Feedback task. These findings provide support for our initial hypothesis that timing-based modality integration, as indexed by the variability of synchronization during Feedback, improves with cortical maturation in adolescents.

The process of coordinating motor movements in time with an auditory pacing beat incorporates several elements: hearing the beat, tracking the beat to make predictions about the next occurrence, planning motor reactions to align movements to the beat, and adjusting these plans when a deviation between the auditory beat and timing of one's movement is detected. Incorporating visual information of these timing deviations (errors) requires additional processing and integration with error-correcting detectors in the auditory system. While auditory asynchronies exist in both experimental conditions, the Feedback condition's explicit representation of offset timing in the visual domain adds another layer of information to integrate and aid entrainment performance.

While auditory feedback can be used to make very fine adjustments, responses to smaller perturbations of less than 20 ms are subliminal (Repp, 2000, 2001). The visual feedback provided in this task makes these small asynchronies explicit, which could contribute to differences between conditions. Although we have previously demonstrated the importance of the auditory midbrain's temporal processing integration abilities for beat synchronization variability (Woodruff Carr et al., 2014, 2016; Tierney & Kraus, 2013a), this is, to our knowledge, the first line of evidence that the ability to correct timing, assessed online, provides an index of cortical maturation. Relationships between better (less variable) synchronization during feedback and reduction of CAEP P1 amplitude and an increase of N1 amplitude is consistent with previous work delineating maturational development across adolescence, both in cross-sectional (P1:

Bishop et al., 2007; Cunningham, Nicol, Zecker, & Kraus, 2000; Mahajan & McArthur, 2012; McArthur & Bishop, 2002; Oades, Dmittmann-Balcar, & Zerbin, 1997; Ponton et al., 2000; Sharma, Kraus, McGee, & Nicol, 1997; Sussman, Steinschneider, Gumenyuk, Grushko, & Lawson, 2008; N1: Bishop et al., 2007; Cunningham et al., 2000; Goodin, Squires,

Henderson, & Starr, 1978; Mahajan & McArthur, 2012; Martin, Barajas, Fernandez, & Torres, 1988; McArthur & Bishop, 2002; Oades et al., 1997; Pang & Taylor, 2000; Ponton et al., 2000; Sussman et al., 2008) and longitudinal (Fitzroy et al., 2015) analyses.

A reduction of P1 amplitude might reflect maturational synaptic pruning of the neural circuitry responsible for generating P1 and improved processing efficiency of P1-generating circuits. Synaptic pruning may also be responsible for an increase in N1 amplitude; decreases in gray matter density in parietal regions (Gogtay et al., 2004) that support attention (Buschman & Miller, 2007; Posner, Walker, Friedrich, & Rafal, 1984) may be indicative of pruning in inhibitory attentional circuits that would lead to disinhibition of neurons involved in generating the N1 CAEP.

Less variable synchronization during Feedback also tracked with intrinsic oscillatory gamma power. High frequency (gamma) EEG oscillations are tied to cognitive processes such as attention (Fan et al., 2007; Fell, Fernández, Klaver, Elger, & Fries, 2003; Tiitinen et al., 1993), memory (Lisman & Idiart, 1995; Tallon- Baudry, Kreiter, & Bertrand, 1999), and the binding of sensory features into coherent percepts (Engel & Singer, 2001). These high frequency rhythms, both spontaneous and sensory-evoked, are generated in neural networks involving excitatory pyramidal cells and inhibitory gamma-aminobutyric acid (GABA) interneurons (Whittington, Traub, Kopell, Ermentrout, & Buhl, 2000). Gamma power decreases over the lifespan (Tierney et al., 2013; Whitford et al., 2007), and there is structural and functional evidence for two potential mechanisms at play that could result in decrease of gamma power with maturation. The first is that in adolescence (10–18 years of age), there is a loss of gray matter in frontal and parietal cortices (Giedd et al., 1999; Pfefferbaum et al., 1994; Steen, Ogg, Reddick, & Kingsley, 1997), which has been interpreted as a reduction in synaptic density due to pruning. Individual resting EEG power has been linked to gray matter volume. Additionally, gamma activity may reflect the extent to which processing in distinct brain regions is coordinated (Engel, König, Kreiter, & Singer, 1991; Engel, König, & Singer, 1991). The areas that support language and reading are distributed throughout the brain; therefore an age-related decrease in gamma power, as observed from scalp electrodes, could also reflect greater localization, specialization, and efficiency of cortical processing with maturation (Benasich et al., 2008; Thompson et al., 2016; Tierney et al., 2014).

Due to the overlap in at least one of these presumed underlying neural mechanisms (synaptic pruning), it might seem that changes in CAEP amplitudes and intrinsic oscillatory gamma power would be redundant measures: after all, a ‘‘better” brain at rest might also result in a ‘‘better” functioning brain. However, this does not seem to be the case here; regression results reveal a lack of relationships between CAEPs and gamma power, and each contributes unique explanations of variance for synchronization variability during Feedback. This is not necessarily surprising because P1 and N1 occur predominantly in the alpha frequency range, and the low- pass filter we employed during CAEP processing removed gamma band activity.

In light of the current findings, we suggest interventions based on beat synchronization might benefit individuals with timing based language disorders, as this skill relates to reading abilities in adolescence and childhood (Tierney & Kraus, 2013b; Woodruff Carr et al., 2014), and music training seems to improve both synchronization and reading skills (Bhide, Power, & Goswami, 2013; Patel, 2011; Slater, Tierney, & Kraus, 2013), possibly via motor structures (Chen, Penhune, & Zatorre, 2008;

Kotz & Schwartze, 2010). Our findings also provide evidence that executive function networks involving the prefrontal cognitive control system are involved when incorporating performance feedback during timing remediation. Direct training of working memory and attention might also boost temporal processing, as evidenced by the success of training paradigms that explicitly train these cognitive skills (Anguera et al., 2013).

Training strategies aimed at improving underlying perceptual and motor processes have been under scrutiny in the learning disabilities community, and training studies provide mixed evidence for generalization of improvement beyond the training tasks to academic skills (Hammill, 1990; Vellutino, Steger, Moyer, Harding, & Niles, 1977). However, there is evidence supporting auditory training for the improvement of communication skills (Hornickel, Zecker, Bradlow, & Kraus, 2012; Merzenich et al., 1996; Tallal et al., 1996; Zuk et al., 2013), although negative results have also been reported (Hook, Macaruso, & Jones, 2001). The present findings provide a lens into adolescent neural maturation and consequent language skills, revealing relationships between a timing-based integration task and cortical auditory-evoked potentials, intrinsic oscillatory gamma activity, and reading subskills. These findings could be useful for clinicians seeking a monitoring tool for intervention outcomes, and future work is needed to determine if providing timing error feedback during synchronization could also be a successful strategy for remediation.

## Author contributions

AT and NK designed research; KWC, ABF, AT, and TW-S performed research; ABF and AT contributed analytic techniques; KWC, ABF, AT, and TW-S analyzed data; KWC, ABF, AT, TW-S, and NK wrote the paper.

Communication Disorders Quarterly
http://cdq.sagepub.com/content/early/2012/09/24/1525740112456422
The online version of this article can be found at:
DOI: 10.1177/1525740112456422
*Communication Disorders Quarterly* published online 28 September 2012
Michaela Ritter, Karen A. Colson and Jungjun Park

# A Preliminary Investigation Reading Intervention Using Interactive Metronome in Children With Language and Reading Impairment:

Published by:
Hammill Institute on Disabilities and http://www.sagepublications.com

## Abstract

This exploratory study examined the effects of Interactive Metronome (IM) when integrated with a traditional language and reading intervention on reading achievement. Forty-nine school-age children with language and reading impairments were assigned randomly to either an experimental group who received the IM treatment or to a control group who did not. Both groups received language and reading intervention, and the experimental group received an additional four hours of IM treatment during a four-week period. Although both groups made gains in reading rate/fluency and comprehension, the extent of the gains was much larger in the IM group. IM training may be useful for promoting the reading rate/fluency and comprehension of children with language and reading impairments.

**Keywords**

reading fluency, comprehension, language and reading impairment, Interactive Metronome (IM) training, temporal processing, processing speed

## Discussion

This exploratory study examined the potential benefits of IM treatment when integrated with a traditional language and reading intervention on the reading fluency and comprehension of school-age children with a language and reading impairment. A major finding of this preliminary investigation was that although both the IM and control groups made significant gains in reading fluency and comprehension, the extent of gain was larger in the IM group.

**Journal of Research in Childhood Education**
Publication details, including instructions for authors and
subscription information:
http://www.tandfonline.com/loi/ujrc20

# Effects of Improvements in Interval Timing on the Mathematics Achievement of Elementary School Students

Gordon E. Taub[a], Kevin S. McGrew[b] & Timothy Z. Keith[c]
[a] University of Central Florida, Orlando, Florida
[b] University of Minnesota, Minneapolis, Minnesota
[c] University of Texas, Austin, Texas
Published online: 22 Jun 2015.

**To cite this article:** Gordon E. Taub, Kevin S. McGrew & Timothy Z. Keith (2015) Effects of Improvements in Interval Timing on the Mathematics Achievement of Elementary School Students, Journal of Research in Childhood Education, 29:3, 352-366, DOI: 10.1080/02568543.2015.1040563
**To link to this article:** http://dx.doi.org/10.1080/02568543.2015.1040563

This article examines the effect of improvements in timing/rhythmicity on mathematics achievement. A total of 86 participants attending 1st through 4th grades completed pre- and posttest measures of mathematics achievement from the Woodcock-Johnson III Tests of Achievement. Students in the experimental group participated in a 4-week intervention designed to improve their timing/rhythmicity by reducing latency response to a synchronized metronome beat. The intervention required, on average, 18 daily sessions of approximately 50 minutes each. The results from this nonacademic intervention indicate the experimental group's posttest scores on the measures of mathematics were significantly higher than the nontreatment control group's scores. This article proposes an integration of psychometric theory and contemporary information processing theory to provide a context from which to develop preliminary hypotheses to explain how a nonacademic intervention designed to improve timing/rhythmicity can demonstrate a statistically significant effect on students' mathematics achievement scores. Keywords: early childhood mathematics, achievement, assessment, educational intervention, mathematics, elementary, intervention, standardized tests

### IP Models and Mathematics Performance Research

IP research has consistently suggested a significant causal relationship between working memory and mathematics performance (Geary, 1993, 2007; Passolunghi & Siegel, 2004). Several authors have reported that working memory plays a crucial role in calculation and in solving arithmetic word problems (Furst & Hitch, 2000; Geary, 1993; Geary, Hamson, &

Hoard, 2000; McLean & Hitch, 1999; Passolunghi, Cornoldi, & De Liberto, 1999; Passolunghi & Pazzaglia, 2004; Passolunghi & Siegel, 2004; Swanson, 1993).

**DISCUSSION**

The purpose of this study was to determine if a short-term, nonacademic STM treatment, designed to improve the timing/rhythmicity abilities of elementary school-age students, would generalize to increased performance in mathematics achievement test scores. This study included 86 participants attending either 1st, 2nd, 3rd, or 4th grade in an inner-city charter school. Participants were randomly assigned to either an experimental group or a control group. The IM method, an SMT-based intervention, was used to improve the experimental group's timing/rhythmicity during 18 separate 50-minute daily SMT intervention treatment sessions. Although the participants in the experimental group received the IM intervention, participants in the control group were in recess. Neither group received academic instruction during the IM treatments. Pre- and posttest performance on two WJ III mathematics achievement tests (Calculation and Math Fluency) was the dependent variable. The ANCOVA statistical procedure was used to analyze all scores, with the participants' pretest mathematics scores serving as the covariant (to control for regression to the mean pre–post test effects).

The results indicated that the SMT method had, on average, a statistically significant effect on the experimental participants' math achievement scores, above and beyond the typically expected 



growth demonstrated on math achievement during the same time frame (i.e., the change in math scores for the control group subjects). As measured by the WJ III Calculation and Math Fluency tests, participants in the experimental group were found to have completed, on average, more mathematics problems, were more accurate in their math problem solving, and completed the mathematics problems faster than the control group.

Although IM training had a statistically significant effect on mathematic achievement scores, the magnitude of the effect was small and accounted for approximately 8% of the variance in the test scores. An alternative way to examine effect size is through Hedges *g* (Howell, 2002). Table 1 presents the effect size for Hedges *g* on Math Calculation and Math Fluency. This statistic may be used to explain effect size as a percentage of growth, using the normal curve distribution. Using this conversion of Hedge's *g*, we found that when compared to the control group, the experimental group experienced a 12% growth on the Calculation test and a 12% growth on the Math Fluency test, when compared to the control groups. These growth rates also compare favorably to the 15% growth, using Hedges *g*, identified in a meta-analysis of phonics instruction conducted by the National Reading Panel's Committee on the Prevention of Reading Difficulties in Young Children (National Reading Panel, 2000). Developmental growth curves based on nationally standardized mathematics tests (McGrew

& Woodcock, 2001) suggest that students of similar age (8.15 years) typically demonstrate little academic growth (as reflected by norm-referenced tests) over a 3- to 4-week period. The detection of significant changes in math achievement scores from a nonacademic intervention after only about 4 weeks and 18 intervention sessions lasting about 50 minutes each is, at a minimum, a significant finding for an initial pilot study and is worthy of further exploration.

## Preliminary Working Hypothesis and Areas to Investigate

Cognitive and intelligence researchers have long sought for (and argued about) the "holy grail" of intelligence—an underlying core essence or mechanism that plays a role in most all intellectual and human performance situations. It is typically referred to as *g*, or general intelligence. The general consensus touches on the concept of neural efficiency (Jenson, 1998). Such a general mechanism or process is considered a domain-general cognitive mechanism, as it works across multiple domains of human ability. Some have referred to such general mechanisms as a "jack-of-all-trade" cognitive mechanism (Chiappe&MacDonald, 2005; akison&Yermolayeva, 2011). This contrasts with domain-specific cognitive mechanisms, which are compartmentalized (modular), brain-based components with limited generalization or transfer effects after training. In addition to the present positive results, previous studies have reported significant effects linking mental time-keeping and academic achievement (e.g., Buhusi & Meck, 2005; Ritter et al., 2013; Taub et al., 2007), dyslexia (McGee, Brodeur, & Symons, 2004; Wolff, 2002), golf performance (Libkuman & Otani, 2002; Sommer & Rönnqvist, 2009), attention, motor control, language processing, reading (Taub et al., 2007), and parent report of regulation of aggressive behavior Shaffer et al. (2001). We believe that, collectively, such cross-domain findings suggest SMT-based interventions must be modifying a domain-general cognitive mechanism. Via task analysis of IM-based SMT training, we offer the hypothesis that the primary mechanism by which working memory is enhanced is the training of controlled attention and inhibition. To stay "on target" requires the subject to focus like a laser on the target tone (for sustained   periods of time) and to shut down or inhibit attention to external or internal (mind-wandering) stimuli. Attentional capture is minimized by the process of inhibition (ignoring task irrelevant distractions—self-generated random thoughts or "mind wandering"). The constant millisecondbased feedback requires participants to suppress attending to distracting external and internal stimuli. The participants' personal mind manager (i.e., executive functions) must constantly monitor the feedback and update immediate working memory so the participants can adjust and correct their synchronization on a real-time basis. Inhibition, shifting, and updating are the three primary cognitive processes believed to be involved in each person's personal mind manager—collectively referred to as the "executive functions" of the brain (Friedman et al., 2008).

The benefit of SMT intervention methods, which focus primarily on maintaining and judging rhythm to a target tone with constant millisecond-based accuracy, may be the enhancement of the domain-general construct of working memory, which, in turn, is strongly related to executive attention and attentional and inhibitory control (Chun, Golomb, & Turk-Browne, 2011; Engle, 2002; Eysenck & Derakshan, 2011; Posner & Rothbart, 2007). We offer the hypothesis that IM-based SMT training may increase the efficiency of attentional and inhibitory control of information being processed in working memory, which may occur through a number of possible mechanisms, either alone or in combination, and result in an increase in the automatization and efficient performance of working memory. This suggests that IM-based SMT training may not improve working memory by increasing capacity, but that SMT training may result in more efficient use of an individual's working memory system. As previously reviewed in this article, working memory abilities are associated with increased performance proficiency in a wide range of complex cognitive performance situations (fluid reasoning, general intelligence, language acquisition, long-term memory storage, reading, and mathematics). Another emerging explanation for interval timing improvement suggests that elementary timing tasks may represent a form of temporal *g* (Rammsayer & Brandler, 2007). Rammsayer and Brandler (2007) recently reported that measures of temporal *g*, which are very similar to the underlying temporal processing required by IM, are more strongly correlated ($r$ = .56) with psychometric g than the standard *reaction time g* ($r$ = –.34), the traditional approach to measuring the *essence* of general intelligence (Jensen, 1998). This suggests that temporal-based interval timing may be a key component of intellectual functioning. The above working set of hypotheses is consistent with McGrew's (2013) three-level hypothesized model for explaining the efficacy if IM training. As summarized by McGrew (2013), IM training (1) increases temporal resolution (faster brain clock rate of neural oscillations), which improves neural efficiency (temporal *g*), which, in turn, (2) improves brain network communicated via increased speed and efficiency of white matter tract processing, particularly between the parietal and front regions of the brain, which, in turn, (3) results in an improved attentional control system, a key component of efficient working memory.

It is recommended that future research should investigate SMT effects at the neurological level (e.g., functional magnetic resonance imaging [fMRI] studies). This may help identify the location(s) of SMT training effects, which, in turn, could help identify relevant cognitive abilities vis-à-vis known brain–behavior relationships. The design of future SMT academic intervention studies should be expanded to include markers of hypothesized cognitive mechanisms (e.g., processing speed, working memory, executive functions, controlled attention) to ascertain which cognitive abilities may be modified via the SMT intervention, and, more important, which cognitive abilities may mediate the changes in academic outcomes. Longitudinal studies are particularly necessary to establish possible underlying domain-general causal mechanisms.

# ANTISAPATORY PLEASURE

## Anatomically distinct dopamine release during anticipation and experience of peak emotion to music


- Valorie N Salimpoor,
- Mitchel Benovoy,
- Kevin Larcher,
- Alain Dagher
- & Robert J Zatorre



Music, an abstract stimulus, can arouse feelings of euphoria and craving, similar to tangible rewards that involve the striatal dopaminergic system. Using the neurochemical specificity of [$^{11}$C]raclopride positron emission tomography scanning, combined with psychophysiological measures of autonomic nervous system activity, we found endogenous dopamine release in the striatum at peak emotional arousal during music listening. To examine the time course of dopamine release, we used functional magnetic resonance imaging with the same stimuli and listeners, and found a functional dissociation: the caudate was more involved during the anticipation and the nucleus accumbens was more involved during the experience of peak emotional responses to music. These results indicate that intense pleasure in response to music can lead to dopamine release in the striatal system. Notably, the anticipation of an abstract reward can result in dopamine release in an anatomical pathway distinct from that associated with the peak pleasure itself. Our results help to explain why music is of such high value across all human societies.


Positive correlation between emotional arousal and intensity of chills during PET scanning.

The mean intensity of chills reported by each participant during the PET scanning session was significantly correlated with psychophysiological measurements that were also acquired during the scan. These are indicative of increased sym…


11. Huron, D. & Hellmuth Margulis, E. Musical expectancy and thrills. in Music and Emotion (eds. Juslin, P.N. & Sloboda, J.) (Oxford University Press, New York, 2009).

# Does music induce emotion? A theoretical and methodological analysis.

Konečni, Vladimir J.
Psychology of Aesthetics, Creativity, and the Arts, Vol 2(2), May 2008, 115-129.
http://dx.doi.org/10.1037/1931-3896.2.2.115

**Abstract**

1. Is music ubiquitous (universal) in part because it is causally linked to emotion? In this article, a comprehensive theoretical and methodological reevaluation is presented of a classical problem: The direct induction of emotion by music (M→E). The author's Prototypical Emotion-Episode Model (PEEM) is used in the conceptual critique. A close scrutiny of the major published studies, and the author's new data regarding some substantive and methodological issues in several of these, reveal weak support for the M→E model. The conclusion seems justified that music may induce low-grade basic emotions through mediators, such as dance and cognitive associations to real-world events. However, it is suggested--on the basis of the recently developed Aesthetic Trinity Theory (ATT; Konečni, 2005) and its further development in the present article--that *being moved* and *aesthetic awe*, often accompanied by thrills, may be the most genuine and profound music-related emotional states. (PsycINFO Database Record (c) 2016 APA, all rights reserved)
**http://psycnet.apa.org/psycinfo/2008-05954-009**

# Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion

Anne J. Blood* and Robert J. Zatorre
Montreal Neurological Institute, McGill University, Montreal, QC, Canada H3A 2B4
Edited by Marcus E. Raichle, Washington University School of Medicine, St. Louis, MO, and approved July 16, 2001 (received for review July 11, 2001)

We used positron emission tomography to study neural mechanisms underlying intensely pleasant emotional responses to music. Cerebral blood flow changes were measured in response to subject-selected music that elicited the highly pleasurable experience of ‘‘shivers-down-the-spine’’ or ‘‘chills.’
’’ Subjective reports of chills were accompanied by changes in heart rate, electromyogram, and respiration. As intensity of these chills increased, cerebral blood flow increases and decreases were observed in brain regions thought to be involved in reward y motivation,

emotion, and arousal, including ventral striatum, midbrain, amygdala, orbito-frontal cortex, and ventral medial prefrontal cortex. These brain structures are known to be active in response to other euphoria- inducing stimuli, such as food, sex, and drugs of abuse. This finding links music with biologically relevant, survival-related stimuli via their common recruitment of brain circuitry involved in pleasure and reward.

These chills were associated with increases in HR, EMG, and RESP relative to the control music condition, indicating changes in autonomic and other psychophysiological activity.

**Specifically, thalamus and AC are thought to be centrally involved in mechanisms of general arousal and attentional processes (41).**

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC58814/pdf/pq011818.pdf

# MUSIC THERAPY

## A review of“music and movement” therapies for children with autism: embodied interventions for multisystem development

***Sudha M.Srinivasan1,2 and Anjana N.Bhat1,2,3**** *1 DepartmentofKinesiology,NeagSchoolofEducation,UniversityofConnecticut,Storrs,CT,USA 2 CenterforHealth,Intervention,andPrevention,UniversityofConnecticut,Storrs,CT,USA 3 CenterfortheEcologicalStudyofPerceptionandAction,UniversityofConnecticut,Storrs,CT,USA*

**EFFECT OF MUSICAL EXPERIENCES ON THE REFINEMENT OF GROSS AND FINE MOTOR SKILLS**

Whole body rhythmic actions such as clapping, marching, or walking to music provide significant opportunities to facilitate gross motor skills.

**MUSICAL EXPERIENCES, PERCEPTION-ACTION LINKAGES, AND BRAIN DEVELOPMENT**

Multiple brain regions, including motor, perceptual, language, and social-emotional systems are stimulated duringmusical expe-riences due to their multimodal, multisystem nature.

Music and language systems also share common neural substrates.
Specifically, the Heschl’s gyrus, planum temporale, secondary auditory cortex, and the corpus callosum are all involved in both music and language processing (Meyer et al., 2002).

**CONCLUSIONS**

In this review, we offered substantial evidence for the multisys-tem effects ofmusical experiences in children with ASDs, healthy individuals, as well as other pediatric neurological populations. We believe that novel, embodied rhythm-based, multisystem interventions grounded in singing, music-making, joint action, and social synchrony can be used to alleviate the core social communication deficits and perceptuo-motor and behavioral comorbidities of children with ASDs. Current evidence for the efficacy of music therapies in children with ASDs comes from a handful of studies that lack systematic study designs, assessments, and treatment protocols. There is an urgent need for systematic research in this field. Our research team has developed an intense, 8-week, novel, embodied musical intervention that will be tested within a pilot, randomized controlled trial to assess its effects on the multisystem performance of children with ASDs. If our hypotheses are upheld, we will be providing objective evidence to support the use of rhythm-based, music and movement inter-vention for children with ASDs. Future research should extend this work by examining multisystem effects of music therapies through larger clinical trials using larger sample sizes.



Groß et al. BMC Complementary and Alternative Medicine 2010, 10:39
http://www.biomedcentral.com/1472-6882/10/39

# Effects of music therapy in the treatment of children with delayed speech development - results of a pilot study

Wibke Groß[1,2*], Ulrike Linden[2], Thomas Ostermann[3]

**Abstract**

Background: Language development is one of the most significant processes of early childhood development. Children with delayed speech development are more at risk of acquiring other cognitive, social-emotional, and school-related problems. Music therapy appears to facilitate speech development in children, even within a short period of time. The aim of this pilot study is to explore the effects of music therapy in children with delayed speech development.

**Methods:** A total of 18 children aged 3.5 to 6 years with delayed speech development took part in this observational study in which music therapy and no treatment were compared to demonstrate effectiveness.
Individual music therapy was provided on an outpatient basis. An ABAB reversal design with alternations between music therapy and no treatment with an interval of approximately eight weeks between the blocks was chosen. Before and after each study period, a speech development test, a non-verbal intelligence test for children, and music therapy assessment scales were used to evaluate the speech development of the children.

**Results**: Compared to the baseline, we found a positive development in the study group after receiving music therapy. Both phonological capacity and the children's understanding of speech increased under treatment, as well as their cognitive structures, action patterns, and level of intelligence. Throughout the study period, developmental age converged with their biological age. Ratings according to the Nordoff-Robbins scales showed clinically significant changes in the children, namely in the areas of client-therapist relationship and communication.

**Conclusions:** This study suggests that music therapy may have a measurable effect on the speech development of children through the treatment's interactions with fundamental aspects of speech development, including the ability to form and maintain relationships and prosodic abilities. Thus, music therapy may provide a basic and supportive therapy for children with delayed speech development. Further studies should be conducted to investigate the mechanisms of these interactions in greater depth.

**Trial registration**: The trial is registered in the German clinical trials register; Trial-No.: DRKS00000343

**Conclusions**

Music therapy according to this study may have a beneficial effect on speech development. It does not seem to influence individual isolated aspects of speech development but might address and integrate many different aspects in a comprehensive way that are important for speech development, including relationship abilities and prosodic abilities. It might be supposed that music therapy interacts with very fundamental aspects of speech development and has measurable effects even after a short period of time. Therefore, music therapy may provide a very fundamental, basic, and supportive therapy for children with developmental speech delay.

Journal of Traditional and Complementary Medicine 6 (2016) 23e28
**Journal of Traditional and Complementary Medicine**
journal homepage: http://www.elsevier.com/locate/jtcme

# Effects of auditory stimulation with music of different intensities on heart period

Joice A.T. do Amaral a, Heraldo L. Guida a, Luiz Carlos de Abreu b, Viviani Barnab_e c, Franciele M. Vanderlei d, Vitor E. Valenti a, *
a Faculdade de Filosofia e Ci^encias, Universidade Estadual Paulista, Marília, S~ao Paulo, Brazil
b Faculdade de Medicina do ABC, Santo Andr_e, S~ao Paulo, Brazil
c Harvard Medical School of Public Health, Boston, MA, USA
d Faculdade de Ci^encias e Tecnologia, Universidade Estadual Paulista, Presidente Prudente, S~ao Paulo, Brazil

## a b s t r a c t

Various studies have indicated that music therapy with relaxant music improves cardiac function of patients treated with cardiotoxic medication and heavy-metal music acutely reduces heart rate variability (HRV). There is also evidence that white noise auditory stimulation above 50 dB causes cardiac autonomic responses. In this study, we aimed to evaluate the acute effects of musical auditory stimulation with different intensities on cardiac autonomic regulation. This study was performed on 24 healthy women between 18 and 25 years of age. We analyzed HRV in the time [standard deviation of normal-to-normal RR intervals (SDNN), percentage of adjacent RR intervals with a difference of duration >50 ms (pNN50), and root-mean square of differences between adjacent normal RR intervals in a time interval (RMSSD)] and frequency [low frequency (LF), high frequency (HF), and LF/HF ratio] domains.

HRV was recorded at rest for 10 minutes. Subsequently, the volunteers were exposed to baroque or heavy-metal music for 5 minutes through an earphone. The volunteers were exposed to three equivalent sound levels (60e70, 70e80, and 80e90 dB). After the first baroque or heavy-metal music, they remained at rest for 5 minutes and then they were exposed to the other music. The sequence of songs was randomized for each individual. Heavy-metal musical auditory stimulation at 80e90 dB reduced the SDNN index compared with control (44.39 ± 14.40 ms vs. 34.88 ± 8.69 ms), and stimulation at 60e70 dB decreased the LF (ms2) index compared with control (668.83 ± 648.74 ms2 vs. 392.5 ± 179.94 ms2). Baroque music at 60e70 dB reduced the LF (ms2) index (587.75 ± 318.44 ms2 vs. 376.21 ± 178.85 ms2).

**In conclusion, heavy-metal and baroque musical auditory stimulation at lower intensities acutely reduced global modulation of the heart and only heavy-metal music reduced HRV at higher intensities.**

# GOOD STUDY



# Using a Therapeutic Music Curriculum to Improve the Social and Academic Skills of Students with Optic Nerve Hypoplasia/Septo Optic Dysplasia

Kimberly Kay Wooster
*Hamline University*, kwooster01@hamline.edu



## Here are some highlights from the paper

**Therapeutic music and understanding emotions.** Helping students with ASD learn to encode (breaking down information into something they could understand) and decode (translating signals into meaning or information) was the goal attempted by Katagiri (2009). Instead of just teaching general social engagement using music to increase student's understanding of social situations, Katagiri (2009); conducted individual sessions to teach four emotions: happiness, sadness, anger and fear. In all cases, the music condition instruction, or the instruction where music was included, showed the most improvement, in students with ASD being able to encode and decode these emotions.

**What is emotion regulation?** Music has long been thought to influence emotions and emotion control. We all know how we like to put on mellow music when we feel stressed, or happy music when we feel low. This is known as mood induction. This is different, however, from emotion regulation. Emotion regulation is geared toward

the specific goal of maintaining a comfortable state of arousal; similarly, that is what we are hoping to accomplish in students with emotion regulation problems (Blaustein & Kinniburgh, 2010; Craig, K., 2013; Diamond & Aspinwall, 2003; McRae et al., 2010;).

**Therapeutic music and self-regulation.** Playing preferred and familiar music was found to contribute to emotional self-regulation and caused students to be happier, less anxious, and more relaxed (Allen & Heaton, 2010; Bakan et al., 2008; Moore, 2013). Because of its variability and flexibility, melodious and harmonious music is useful in counteracting the rigid characteristics of ASD (Wigram & Gold, 2005);



however, playing music that was complex or dissonant or even unexpected, caused students to react negatively and made it more difficult to regulate their behavior and struggle with social inclusion (Wigram, T. & Gold, 2005).

**Improvising music contributes to emotional regulation.** In addition to the above discovery, Kim (2009) found that allowing the students to improvise in their therapeutic music class contributes to success in regulating their behavior. In particular, improvisational music engages children and promotes the development and reciprocal and interactive communication and play (Edgerton, 1994; Wigram, 1999, 2000). This is something to keep in mind when planning therapeutic music for students with ONH/SOD several studies have shown that students were calmer when they were not always teacher-directed, and they could explore the instruments with their sounds and textures with guidance, but not specific direction (Kim et al., 2009; Edgerton, 1994; Gourgey, 1998; Wigram, 1999; Wigram 2000).

**Social Engagement and Language**

Music may be able to help restructure the environment for children with visual impairments (Ockleford, 1998a; Ockleford, 1998b). Therapeutic music may help promote joint attention (the ability to share a common focus on something) and increase theory of mind development (the understanding of one's own and other people's minds or mental states)(Kim et al., 2008; Ockleford, 1998a; Ockleford 1998b; Simpson & Keen, 2011). Therapeutic music may help blind students develop a way to communicate in a way that doesn't include words. In fact, the music may become a proxy or substitute for language



because music reaches below the level of words for a child, providing a way to communicate close to the child's abilities (Gourgey, 1998).

**Music helps with transitions.** Studies have shown that using music increases success with transitions in the classroom. Behar (2003) shares how teachers in their study used music to increase success with learning and transitions in the academic classroom. The teachers used exaggerated intonation and clapping to the syllables of the word the students were trying to learn. This immediately focused the children's attention on what they were teaching them. It is as if the music allowed the students' brains to become alert and learn. And when it came time for the student to transition to another classroom and teacher, the instructors would clap the name of the next teacher too. Eventually, when

teachers would clap and say the name of the next teacher, the students would try to say that teacher's name as well (Behar et al., 2003; Buday, 1995; Craig, 2013; Nordoff & Robbins, 1971a; Nordoff & Robbins, 1971 b).

**Music helps calm and focus.** Buday (1995) conducted a study that confirms the information that Behar offered. Students were taught specifically-selected signs in two different ways: One of the studies was conducted using only rhythm as a reinforcer, while the second study was conducted using music with the teaching of the signs (Buday, 1995). It was discovered that there was a significantly higher incidence of correct answers for the signs learned in the music condition over the rhythm condition (Buday, 1995; Nordoff & Robbins, 1971a; Nordoff & Robbins, 1971b). It has been suggested that because of the positive calming and focusing responses to music by those with ASD, this can help increase participation in activities that will help them achieve goals in the social and language domain (Behar et al., 2003; Baken et al., 2008; Nelson, Anderson & Gonzales, 1984).

**Is Therapeutic Music Effective**

I believe therapeutic music is effective because therapeutic music harnesses the musical strengths of the ASD population while alleviating their impairments, (Srinivasan & Bhat, 2013). Whipple (2004) conducted a meta-analysis of nine studies that concluded that music was effective irrespective of the age of participants, type of intervention, treatment, methodology, and profession of the music provider.

In 2009, the National Autism Center agreed when it classified music as an emerging, evidenced-based practice, useful in teaching individual skills or goals by initially targeting the skill through song or rhythmic cuing (Kim et al., 2009). This project reported on six studies that used a range of music techniques. Though there were some weaknesses in the studies, including small sample sizes and studies of short duration, there was a clear improvement, particularly in non-verbal communication in those who were involved in the study (Kim et al., 2009; Gourgey, 1998).

**Communication skills increased.** Edgerton (1994), during individual sessions while using improvisational music theory, found that therapeutic music increased musical and nonmusical communicative behaviors for a group of 11 children aged 6-9 years. They used The Checklist of Communicative Responses/Acts Score Sheet (CRASS) designed specifically for the study to measure non-musical and musical communicative responses and acts. This assessment predominantly measured musical categories and communicative responses. It was found that if the student loved music, it could be used to initiate communication with the student. Motivating the student with the reward of music could encourage the student's interaction with others, flexibility in situations, adjustment to change, and more ease in decision making (Baken et al., 2008; Craig, 2013; Edgerton, 1994; Srinivasan & Bhat, 2013).

Patel (2003) proposed a hypothesis labelled OPERA (Overlap, Precision, Emotions, Repetition, and Attention) to explain how music may produce such positive effects on communication or language. (1) Speech and music processing centers Overlap in the brain. (2) The Precision required for music is even stronger than that required for speech. (3) Emotions evoked by music are strong and positive. (4) Success in music making requires Repetition and practice. Lastly, (5) Attention is required for the successful performance of music. Taken together, the experience of making music may bring about the most growth in language for those with ASDs (Patel, 2011).

**Social engagement improved**. A number of studies describe the success of music used as an intervention to develop socialization skills in children with autism. Different emotions such as fear, anger, happiness, and sadness can be communicated to the listener through different musical elements such as tempo, intonation, and sound level (Katagiri, 2009; Kern & Aldridge 2006; Kim et al., 2009; Simpson et al., 2011). Music was embedded into an outdoor play context and then the study compared baseline conditions between non-directed music activities and teacher and peer mediated music intervention. When the teachers and peers composed and sang songs, the play sessions resulted in an increase in positive peer interactions.

**Music and socialization.** Evvard (1978) suggests using music to teach socialization. For instance, he suggests that a song be played and as each student's name is called, they be asked to stand, shake hands with their neighbor, and say hello. He suggests that music class could involve the group as a whole dancing in a circle while holding hands, and class could conclude with a **"**Goodbye Song," with each child dismissed by name. Taking turns would be an important part of learning to socialize. Another activity included listening games involving instruments played at different auditory levels with the students instructed to move closer to the sound as it grows louder. All of these strategies are included in the therapeutic music curriculum I am proposing.

The music condition was significantly more effective than regular play sessions, increasing eye contact and attention behaviors, and the children engaged in longer periods of turn taking during music playtime. Interestingly, the frequency and duration of 'joy', 'emotional synchronicity', and 'initiation of engagement' was higher and lasted longer during non-directed sessions versus the directed sessions of music. Incidentally, active engagement during singing lessons correlated with improvements not only in singing but also in social inclusion. (Kern et al., 2013; Nordoff & Robbins, 1971a).

**Therapeutic Music Used to Modify Blindisms and Echolalia**

Auditory defensiveness is one of the behaviors associated with students with ONH/SOD. In order to help the students with ONH/SOD assimilate into their classrooms, it is important to assist them in modifying this behavior. Research has shown some

success with the use of therapeutic music to this end. If the student is exposed to music in the classroom, at increasing volumes, it can help to desensitize the child to sounds and make it easier for the student to be in a variety of noisy, stimulating environments (Behar et al., 2003).

**Modifying blindisms.** Blindisms include: repetitive rocking, eye rubbing, hand gestures, head rolling or banging, and/or staring at light sources (Gourgey, 1998). Rocking movements are the most common of the blindisms, and children may respond well to the rhythms of music. If blindisms are indeed related to self-stimulation, the added stimulation of music may, over time, help modify these patterns. The creative use of rhythm in musical improvisations provides the stimulation children seek while also helping them to respond to outside stimulation. (Gourgey, 1998)

**Modifying echolalia.** Another "autistic-like" symptom in children who are blind is echolalia**:** the echoing in parrot-like fashion the words they hear spoken to them (Warren, 1984). In order to help modify echolalia, the music teacher may use songs that require song completion. As the child becomes more comfortable with the song, which has become very familiar, the child may learn to complete the song without help from the teacher. Bruscia (1982) described these kinds of exercises as the beginning of the first steps toward the treatment of echolalia (Gourgey, 1998).

**Music Obsession**

A cautionary note, however, is that sometimes if students are completely immersed in repetitive music, songs, and tapes, to the exclusion of other activities, this focus may prevent further exploration and learning opportunities (Bahar et al., 2003). Since students with ASD can become obsessed with one song or activity, it is important to use a variety of techniques.

**Guidelines for Choosing Appropriate Music**

Several studies have suggested that when working with students with language deficits, it is important to choose the music carefully and include specific guidelines in the areas of intonation, rhythm, range, and tempo. In practice, the most critical elements are listening, singing, music-making, and rhythmic actions played or sung in time to music, experienced individually or in socially embedded group activities (Edelson et al., 1999; Nordoff & Robbins, 1971a, Nordoff & Robbins, 1971b).

It should be noted that there is value in also choosing music that is developmentally appropriate (Kern et al., 2013;Wigram, 2005) and preferred by the client. We all know that we exercise or work better to music we like. In just this way, preferred music is intrinsically motivating for children. Using music they prefer also builds pride in their accomplishments and in their independence and provides opportunities for increased socialization. (Dockery, 2014).

**Mirror cadence, tempo and pattern of actual speech.** It is suggested that songs should be chosen that closely mirror the cadence, tempo and pattern of actual speech; in addition, the melodic rhythm should be similar to that of speech, wherein a syllable stressed in speech should correspond to a strong beat in a measure of music.
Singing songs with repeated lyrics is also important for helping students practice language. It is easiest for students to learn language through songs where the lyrics are repeated (Nordoff & Robbins, 1971a, Nordoff & Robbins, 1971b).
In addition, as many children with language impediments have difficulties singing high-pitched notes, choosing songs with melodies ranging around middle C is considered best (Craig, 2013).
In one example, while a hello song is played, each child could be told to stand as they were greeted, and then be asked to shake hands with their neighbor as they say hello. Learning to take turns would also be an important part of socialization in which music can play a part (Gourgey, 1998). Other activities could involve the group as a whole with children dancing a circle dance holding hands. Music class could conclude with a "Goodbye Song," in which each child would be dismissed by name. (Nordoff & Robbins, 1971a).

**Listening Activities**
In addition to the above exercises, Evvard (1978) suggested other activities that could help students explore their environment. The teacher could play an instrument below the threshold of audibility, gradually increasing the volume until the students could hear it, at which time, they could respond by playing their instrument.
The teacher could also play an instrument such as a chime at a distance from the students and ask the student to move toward the sound. Teachers also might play an instrument and ask the student to move toward them only when they hear a specific tone, thus teaching them about auditory discrimination (Evard, 1978; Gourgey, 1998).

**Help Managing Sensory Overload**
In one example, a student who was blind with autistic characteristics found that therapeutic music helped him learn to adjust to changes in his environment. Children with ONH/SOD often "misread" sensory cues and either over-or underreact to noises, withdrawing, covering their ears with their fingers or screaming (Behar et al., (2003).
Born with absolute pitch (AP) and the ability to learn music quickly and easily, this student was able to use music as a way to calm himself when he was agitated (Craig, 2013).

**When a Student is Withdrawn**
When a student withdraws due to overstimulation in the environment, or auditory defensiveness, it can be helpful to attach physical interaction to the music (e.g., clap, fall down, go up or down), which may maintain the child's attention, while the classroom is

modeling appropriate and meaningful language (Behar et al., 2003).

**A Life Changing Experience for Jerry**

One study, involving a young man named Jerry, showed that music was able to unlock his world of communication (Nordoff & Robbins, 1971a). Though he was born into a highly musical family, and he had shown early interest and talent for music, he was unfortunately not offered therapeutic music until he was 18 years old. Through music, he learned to make eye contact, improvised accompaniment, and even learned to hold hands with the teacher while dancing. (Clarkson, 2001)

Using music and Facilitated Communication (FC), a way of assisted writing developed by Rosemary Crossley, an Australian special educator (Bicklen, 1993), Jerry learned to communicate, and eventually became less violent (Clarkson, 2001). By the fall of 1992, Jerry could maintain good eye contact in music class for 50 minutes at a time. He smiled often and had not thrown a temper tantrum in music classes in three years (Clarkson, 2001).

In FC, a facilitator supports the hand, wrist, or elbow of the individual, who selects letters and forms words on an alphabet board, Canon communicator, electric typewriter, or computer keyboard. As the student becomes more independent, the facilitator gradually fades their support (Clarkson, 2001).

This technique has generated controversy through the years, as some feel that the facilitator may be manipulating the outcome of the student's writing; however, in many cases, the student uses unique phonetic spellings and mentions names, places, or events about which the facilitator has no knowledge at the time, but later verified, as in Jerry's case (Clarkson, 2001).

The ability of Jerry to type complete sentences with help from his facilitator and, eventually, with help from the music teacher, was amazing. He even went on to express how it felt to be autistic by comparing it to feeling like a dam being plugged up. In his case, it was therapeutic music and FC that allowed the dam to open (Clarkson, 2001).

## In Conclusion

In this chapter I have explained what ONH/SOD is and how it affects student's social and academic lives.

Then I have explored whether children who are born with visual impairment are blessed with natural musical interest and ability. Next, in the literature, I discovered a link between children who are blind and those who have ASD. And lastly, I have found research to support the theory that therapeutic music helps improve the academic and social behaviors of students with ASD.

In addition to the above information, I shared the different ways therapeutic music helps to improve academic and social behaviors. Therapeutic music improves the lives of

students with ASD and ONH/SOD by helping to calm, focus, and increase socialization skills, along with providing tools to help decrease blindisms and echolalia.

I also discovered and shared what kinds of music are most effective and how it can be used. These included choosing music that mirrors cadence, tempo and patterns of speech, choosing songs in low and mid-range so they can be easily sung, and choosing songs that show socialization.

After studying the literature presented in this review, it is apparent to me that there is a need for more controlled in-depth scientific studies to be conducted on how music affects children with ONH/SOD, and whether its use can improve the academic and social outcomes in their lives.

In chapter three, I will outline the methods I will use to design and create a therapeutic music curriculum to use in improving the social skills and behaviors of elementary students with ONH/SOD. I will use evidence based instructional strategies including Understanding by Design, (UbD) and Differentiated Instruction, (DI) when creating the curriculum guide (McTighe, 2005). I will also include the curriculum and the assessment tool as designated in the curriculum guide, as well as identify for whom the curriculum will be intended.

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# MOTIVATION

Runners can best improve their performance with motivating music that has a clear and constant beat. The motivating aspects enable a runner to make more effort and as a result of the synchronization he or she will run more efficiently.

NOW researcher Melvyn Roerdink Jouranl PLoS ONE.
Medical Press
http://medicalxpress.com/news/2013-08-running-and-rehabilitation-improved-with.html

**International Journal of Science Culture and Sport (IntJSCS)**
December 2015 : 3(4) ISSN : 2148-1148 Doi : 10.14486/IntJSCS458

***Field :*** *Sport Sciences*
***Type :*** *Research Article*
***Recieved:****01.11.2015* - ***Accepted:****10.12.2015*

# Motivational Effects of Music on Performance and Learning a Chain Skill in Children

**Mohammad Taghi AGHDASI[1], Zohreh NAJMABADI[2], Maryam JAHEDI[2], Samira Maafi ASL[2]**
[1] Dr., Associate Professor in Motor Behavior, Physical Education and Sport Science Faculty, University of Tabriz, Tabriz, East-Azerbaijan, IRAN
[2] MSc student of Motor Behavior, Physical Education and Sport Science Faculty, University of Tabriz, Tabriz, East-Azerbaijan, IRAN **Email**: najmabadyzohreh@yahoo.com

## Abstract
The aim of this study was to evaluate the effect of motivational factors of music on performance and learning a chain skill in children. For this purpose, 24 healthy non-athlete 11-year-old girls were selected from two fifth grade class by available sampling method and were randomly divided into experimental and control groups. After the training the participants were given a pre-test. The training program in the acquisition phase was a chain skill including rolling, shooting football and receiving and passing the basketball for 8 weeks (two sessions per week with a pack of 4 attempts) which was performed with the existence of motivational factor of music in the experimental group and then a post-test was taken. Finally, after three weeks of not training, retention and transfer tests were taken. The data were analyzed through co-variance analysis and independent and paired sample t-test. The results showed that both groups have had progress in acquisition of the skill ($p<0.01$) but there was no significant difference between scores of the two groups ($p>0.05$). There was also no significant difference between retention and transfer test scores of the two groups. According to the findings of the study, it can be said that the motivational factor of music alone is not effective on motor performance and learning of children.

Keywords: Music, acquisition, retention, transfer, chain skill, children

# The BASES Expert Statement on the Use of Music in Exercise

**Produced on behalf of the British Association of Sport and Exercise Sciences by Dr Costas I. Karageorghis FBASES, Prof Peter C. Terry FBASES, Prof Andrew M. Lane FBASES, Dr Daniel T. Bishop and Dr David-Lee Priest**

Synchronous music use (i.e., when an exerciser consciously moves in time with a musical beat) has been shown to provide ergogenic and psychological benefits in repetitive endurance activities.

For example, motivational synchronous music used during treadmill walking improved time to voluntary exhaustion by 15% compared to motivationallyneutral and control conditions (Karageorghis *et al*., 2009). Other findings suggest that synchronous music may increase rhythmicity of movement, resulting in an efficiency gain that is associated with lower relative oxygen uptake (see Terry & Karageorghis, 2011).

In steady-state aerobic exercise, motivational music has also been shown to improve affective states by up to 15%. Similarly, music listening can be an effective dissociation strategy, reducing perceptions of effort and fatigue by up to 12%. However, this distraction effect is attenuated at higher exercise intensities (> ~70% $VO_{2\ max}$) as internal feedback dominates due to the limited channel capacity of the respective afferent nervous system. Notably, the affective and attentional effects of music appear to interact, in that positive feelings can alter perception of intense effort. The effects of post-exercise music, to aid recovery from training, competition or injury – known as recuperative music – are now beginning to receive research attention (see Terry & Karageorghis, 2011).

## Conclusions and recommendations

Research evidence demonstrates that music has consistent and measurable effects on the behaviour and psychological states of male and female exercise participants. Music can also positively influence performance by improving endurance and/or exercise intensity. When music is selected according to its motivational qualities, the positive impact on performance (e.g., increased endurance) and psychological states (e.g., enhanced affect) are even greater, which has important implications for exercise adherence. Salient recommendations are that music should be:

- Congruent with the socio-cultural background and age group of listeners (i.e., reflect familiarity and preferences).
- Functional for the activity (e.g., rhythm should usually approximate motor patterns involved).
- Selected with the desired effects in mind (e.g., loud, fast, percussive music with accentuated bass frequencies as an arousal-increasing intervention).
- Selected in consultation with participants using some form of objective rating method (e.g., Brunel Music Rating Inventory-2; Karageorghis *et al*., 2006).

• Characterised by prominent rhythmic qualities and percussion in addition to pleasing melodic and harmonic structures for repetitive aerobic and anaerobic exercise tasks. Harmony refers to sounding multiple notes together, giving music
its emotional "colour" (e.g., happy, sad, ruminative).
• Within the tempo band of 125-140 beats per minute for most healthy exercisers engaged in repetitive, aerobic-type activity (slower music is appropriate for warm-up and cool-down).
• Imbued with motivating associations, conditioned either through the media or the personal experiences of the listener.
• Accompanied by lyrics with affirmations of movement (e.g., "run to the beat") or generic motivating statements (e.g., "the only way is up").
• Used in ways where safety is not compromised (e.g., exercisers should not use music when running or cycling on the roads).

# Socialization

According to Dekker et al. (2992), the most prominent problem behaviors of children wit ID were social problems, attention problems, and aggressive behavior as reported from their parents and teachers.

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# LEARNING DISORDERS/DISABILITIES

Learning is a core process of human growth and development. It is a key enabler of change in human behavior. Learning results in changes in behavior and the knowledge, skills and emotional reactions underlying behavioral. Through learning we can adapt to changes in our environment and also actively influence our environment and our own behavior as part of it. Learning is always an active and interactive process which takes place in a cultural and social context. Experiences obtained from the growth environment both cause and regulate learning. PHYSICAL Activity AND LEARNING • SUMMARY

"Learning disabilities are not a prescription for failure. With the right kinds of instruction, guidance and support, there are no limits to what individuals with LD can achieve."
Sheldon H. Horowitz, Ed.D., Director of LD Resources.
National Center for Learning Disabilities:

The DSM uses the term "specific learning disorder." Revised in 2013, the current version, DSM-5, broadens the previous definition to reflect the latest scientific understanding of the condition.

> The diagnosis requires persistent difficulties in reading, writing, arithmetic, or mathematical reasoning skills during formal years of schooling. Symptoms may include inaccurate or slow and effortful reading, poor written expression that lacks clarity, difficulties remembering number facts, or inaccurate mathematical reasoning:
>
> Current academic skills must be well below the average range of scores in culturally and linguistically appropriate tests of reading, writing, or mathematics. The individual's difficulties must not be better explained by developmental, neurological, sensory (vision or hearing), or motor disorders and must significantly interfere with academic achievement, occupational performance, or activities of daily living.
>
> Specific learning disorder is diagnosed through a clinical review of the individual's developmental, medical, educational, and family history, reports of test scores and teacher observations, and response to academic interventions.

(*Specific Learning Disorder* fact sheet, American Psychiatric Association, 2013) The State of Learning Disabilities: Facts, Trends and Emerging Issues | LD.org

# A PRELIMINARY STUDY OF CREATIVE MUSIC THERAPY IN THE TREATMENT OF CHILDREN WITH DEVELOPMENTAL DELAY

DAVID ALDRIDGE, PhD, DR. RER. MED. DAGMAR GUSTORFF and DR. RER. MED. LUTZ NEUGEBAUER*

Pergamon
0197-4556(95)00019-4
The Arts in Psychotherapy, Vol. 22, No. 3, pp. 189-205, 1995

0197-4556195 $9.50 + .oO

This paper has two main purposes. The first is an attempt to demonstrate that creative music therapy is a viable therapeutic form for developmentally delayed children, and in doing so elucidate what it is in the therapy that is valuable. For referring patients, paediatricians and payers (possible funding agencies and third-party medical insurers) alike, we need to present evidence that the work that we are engaged in has a value that makes sense to them. Although we, as therapists and researcher, are convinced of the value of our own work according to our criteria, we too are seeking ways to understand how what we do is effective. The process of looking at clinical practice, sometimes from a different perspective, gives the possibility to gain a valuable insight into what we are doing, to promote that work in other settings and to broaden the basis of our teaching.
The second purpose is to present an integrated approach to music therapy research that combines both a quantitative approach, as shown by measuring changes, and a qualitative approach, as argued from the interpretation of empirical data. Although this second purpose may seem rather unorthodox, the reason underlying it is that we hope to show that in music therapy research we can creatively adapt techniques and forms of argumentation to suit our needs and that we do not have to take a polarized stance either for or against qualitative or quantitative methods. Indeed, to maintain an ideological position is to fall into the trap of methodolatry on one hand or scientism on the other. Research methods are simply tools for structuring our thinking and gathering the evidence that we will use to support our arguments. In some ways we are rehearsing a debate that has already been comprehensively **argued** in both the fields of nursing (Dzurec & Abraham, 1986, 1993) and social psychology (Shadish & Fuller, 1994). By relating both sets of information it may be possible to generate insights not available from the two types of information separately (Heyink & Tymstra, 1993).

The overall aim of our research then is to present our work with children suffering from a variety of developmental challenges and propose that by using a particular form of assessment available to other music therapists we can see quantitatively that a beneficial

change occurs. The reason for that change, we will argue, is attributable to specific qualities of creative music therapy.

The music therapy approach taken here is based upon that of Nordoff and Robbins (1977) improvised music therapy, which has its origins in working with handicapped children. However, although there is a wealth of case study material in the music therapy literature concerning music therapy with children and a considerable literature suggesting the value of music therapy for child development (Wilson & Roehmann, 1987), there have been few controlled studies of Nordoff and Robbins music therapy with handicapped children. An important feature of childhood development is *David Aldridge is Professor for Clinical Research Methods at the University of Witten Herdecke, Germany. Dagmar Gustorff and Lutz Neugebauer are Co-Directors of the Institute for Music Therapy at the University of Witten Herdecke.
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J. Spec. Educ. Res. **6**(1): 1–9 (2017)
Original Article

# Influence of Early Social-Communication Behaviors on Maladaptive Behaviors in Children With Autism Spectrum Disorders and Intellectual Disability

Yuuya Nagai*, Toshihiko Hinobayashi and Tadahiro Kanazawa
Osaka University, Japan

We investigated the relationships between early social-communication behaviors and maladaptive behaviors in children with autism spectrum disorders (ASD). Fifty-three children with both intellectual disabilities and developmental disorders including ASD participated in the current study. The results of a stepwise multiple regression showed that frequency of initiating joint attention and rate of positive affect expression were independent negative predictors of internalizing problems; severity of ASD symptom and frequency of requests were positive predictors, and rate of positive affect expression was a negative predictor, of v-scale score for externalizing problems.

_ese results demonstrated that different types of early social-communication behaviors influence different kinds of maladaptive behaviors in children with ASD. In particular, positive affect expression with communication was a negative predictor of both internalizing and externalizing problems. It is critical that we explore how maladaptive behaviors develop in children with ASD, with a particular focus on the development of early social communication.

Key Words: autism spectrum disorders, early social-communication behaviors, joint attention, maladaptive behaviors

**Introduction**

Autism Spectrum Disorders (ASD) is defined by the following Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) diagnosis criteria (American Psychiatric Association, 2013): (1) persistent deficits in social communication and social interaction across multiple contexts; (2) restricted, repetitive patterns of behavior, interests, or activities; (3) symptoms must be present in the early developmental period; and (4) symptoms cause clinically significant impairments in social, occupational, or other important areas of current functioning. Baron-Cohen (2008) noted that scores indicating ASD traits in typically developing adults were normally distributed, and all adults have ASD traits to some extent. therefore, early diagnosis of ASD is difficult, and early detection of behavioral indicators tends to be delayed in the absence of knowledge about ASD children acquired from both training and clinical experiences. Reduced joint attention in infancy is important for early detection of ASD (Baron-Cohen, Allen, & Gillberg, 1992).

However, ASD has been detected based on a history of language delay and maladaptive behaviors. Previous work found that children with ASD exhibited maladaptive behaviors more frequently than children without ASD (e.g., Ando & Yoshimura, 1979; Dominick, Davis, Lainhart, Tager-Flusberg, & Folstein, 2007; Hartley, Sikora, & McCoy, 2008).

Maladaptive behaviors in children with ASD may increase risk of exclusion from educational settings, social relationships, and community activities (e.g., Brereton, Tonge, & Einfeld, 2006), and cause more distress to caregivers (e.g., Hastings, Kovshoff, Ward, Espinosa, Brown, & Remington, 2005). Many researchers have investigated possible interventions for reducing maladaptive behaviors in children with ASD (e.g., Horner, Carr, Strain, Todd, & Reed,2002). For example, Charlop-Christy, Carpenter, LeBlanc, and Kellet (2002) reported that an intervention using the Picture Exchange Communication System (PECS; Bondy & Frost, 1994), which teaches functional and spontaneous communication skills, reduced maladaptive behaviors in children with ASD. PECS training improved social-communication behaviors such as requests and joint attention (e.g., Lerna, Esposito, Conson, Russo, & Massagli, 2012). However, previous work did not demonstrate why PECS training reduced maladaptive behaviors in children with ASD. Maladaptive behaviors in children with ASD, especially in the pre-school period, are related to social-communication skills (e.g., Dominick et al., 2007; Koegel, Koegel, & Surratt, 1992; Prizant, Schuler, Wetherby, & Rydell, 1997; Prizant, Wetherby, Rubin, Laurent, & Rydell, 2006), severity of ASD symptoms (Dominick et al., 2007), sensory processing (e.g., O'Donell, Deitz, Kartin, Nalty, & Dawson, 2012), and intellectual ability (e.g., Dominick et al., 2007; Ito, Tani, Yukihiro, Uchiyama, Ogasawara, Kuroda, Inada, Hagiwara, Hara, Iwanaga, Inoue, Murakami, Someki, Nakamura, Sugiyama, Uchida, Ichikawa, Tanaka, & Tsujii, 2012). Most of these variables were evaluated indirectly

via questionnaires or interviews, and few studies have objectively quantified behavior in children with ASD. Early social-communication during the pre-verbal period includes three forms of intersubjectivity: sharing attention, emotion, and intention (Stern, 1985).

Previous work found that children with ASD exhibit fewer of these early social-communication behaviors. _ere are two forms of joint attention behavior involved in sharing attention: initiating joint attention (IJA) and responding to joint attention (RJA; e.g., Mundy, Delgado, Block, Venezia, Hogan, & Seibert, 2003). IJA and RJA have di_erent functions. IJA is related to sharing positive affect (Bakeman & Adamson, 1984). In contrast, RJA is more likely associated with response inhibition (Vaughan Van Hecke, Mundy, Block, Delgado, Parlade, Pomares, & Hobson, 2012). Children with ASD show less IJA and RJA than children with developmental disorders without ASD (e.g., Mundy, Sigman, Ungerer, & Sherman, 1986), suggesting that children with ASD have difficulty in sharing attention. A recent study showed that low-level IJA (IJA-LL; coordinated gaze shi_s) and high-level IJA (IJA-HL; pointing and/or showing) are deferentially related to measures of later social-communication skills (e.g., imitation) in children with ASD (e.g., Pickard & Ingersoll, 2015).

Children with ASD display positive affect expressions less frequently than children with developmental disorders without ASD in communication situations (Dawson, Hill, Spencer, Galpert, & Watson, 1990; Kasari, Sigman, Mundy, & Yirmiya, 1990), and children with ASD have difficulty sharing emotions with others. Furthermore, Phillips, Gómez, Baron- Cohen, Laá, and Rivière (1995) showed that children with ASD make fewer requests by looking at a communication partner's face than children with developmental disorders without ASD. _is behavior implies recognition and perception of information processing in others (Gómez, Sarria, & Tamarit, 1993). _is result suggests that children with ASD have difficulty sharing intentions with others. _ese results were derived from evaluating behaviors of children with ASD in a limited test situation.

Because children with ASD may not demonstrate their real ability in unfamiliar environments such as a test situation, previous work may not accurately re_ect their ability. In this study, we investigated whether early social-communication behaviors occur less frequently in children with ASD than children with developmental disorders without ASD by directly observing behaviors in a free-play situation, which is part of participants' daily life and therefore higher in ecological validity than the unfamiliar test situation. In addition, we investigated the relationships between these behavior indices of early social communication behaviors through direct observation and maladaptive behaviors rated by their caregivers in children with ASD.

## Discussion

In this study, we investigated whether early social communication behavior occur less frequently in children with ASD than children with developmental disorders without ASD by

directly observing behaviors during free-play situations, which are part of daily life for these participants. In addition, we investigated the relationships between early social-communication behaviors and maladaptive behaviors.

_e results showed that children with ASD performed early social-communication behaviors less frequently during group free-play than children with DD. _is is consistent with previous work showing difficulties in early social-communication in children with ASD (e.g., Kasari et al., 1990; Mundy et al., 1986; Phillips et al., 1995). Children with ASD showed difficulties in all social-communication behaviors in the pre-verbal period by Stern (1985). Moreover, we were able to detect differences between children with and without ASD in a free-play situation by quantifying early social-communication behaviors through direct observation. In general, children with ASD have difficulty predicting what will happen next, and o_en refuse to participate in psychological tests or even enter the testing room. Consequently, they are excluded from analyses of test situations. In this respect, behavior observation in a free-play situation is useful because children with ASD can demonstrate their abilities without a psychological burden, and natural behaviors can be evaluated. We also sampled behaviors four times, because the frequency of social communication behaviors could _uctuate according

**Table 5** Results of Stepwise Multiple Regression Analysis: Early Social-Communication Behaviors as Predictors of Maladaptive Behavior for the ASD Group Maladaptive behavior Internalizing problem Externalizing problem
β *t* *p* VIF β *t* *p* VIF β *t* *p* VIF
Request .36 2.57 .01 1.11
IJA-LL
IJA-HL −.54 −4.31 .00 1.04
Eye-contact
Positive a_ect expression −.23 −1.83 .07 1.04 −.29 −2.15 .04 1.05
PARS .42 3.00 .01 1.00 .43 3.07 .00 1.10
CA
DA
*Note.* Maladaptive behavior: $R2$=.16, $F(1, 41)$=8.99, $p$<.01, Internalizing problem: $R2$=.36, $F(2, 40)$=12.98, $p$<.01, Externalizing problem:
$R2$=.26, $F(3, 39)$=5.97, $p$<.01, β =standardized beta coe_cients, VIF=variance inaction factor

 to the child's physical condition of the day. Sampling in this study re ected the reality of participants.

Behavior observation in a group free-play situation is useful for evaluating early social-communication behaviors in children with developmental disorders including ASD.

Another controlling for chronological and developmental age, frequency of IJA and ratio of eye-contact with request were negatively correlated with severity of ASD symptom; frequency of requests and ratio of positive a_ect expression with communication were not correlated with each other. Although this study showed that children with ASD displayed fewer early social-communication behaviors than children with DD, some behaviors were not correlated with severity of ASD symptom. _ese results indicate that early social-communication behaviors, especially those related to joint attention, may be related to severity of ASD symptom. V-scale score for maladaptive behaviors was higher in children with ASD than children with DD, and was correlated with severity of ASD symptom. _ese results are consistent with previous work (e.g., Dominick et al., 2007). In addition, the results of a stepwise multiple regression showed that frequency of IJA-HL and ratio of positive a_ect expression with communication were independent negative predictors of v-scale score for internalizing problems; severity of ASD symptom and frequency of requests were positive predictors, and ratio of positive a_ect expression with communication was a negative predictor of v-scale score for externalizing problems. Previous work showed that social-communication ability might influence maladaptive behaviors in children with ASD (e.g., Koegel et al., 1992). _is study adds to the literature by showing that social-communication behaviors differentially influence externalizing and internalizing problems. _e di_erent functions of social-communication behavior might predict different kinds of maladaptive behavior. Bates (1976) divided non-verbal communication into protoimperative and protodeclarative communication. Protoimperative communication is de_ned as behavior that uses others to work on objects, and corresponds to requests in this study. Protodeclarative behavior is de_ned as behavior that uses objects to get others' attention, and corresponds to IJA in this study. _e results of this study showed that, in children with ASD, v-scale score for externalizing problems increased as the frequency of requests increased.

Children with ASD who show a lot of self-expression, including requests, might also tend to not inhibit externalizing problems such as violence and temper tantrums. _ese children might be classified as "active, but odd interaction" ASD type, according to Wing and Gould (1979). Therefore, their frequent requests may be one factor that increases externalizing problems. _e more frequently they request, the more frequently they are refused by others and become angry. Accumulation of such negative experiences may lead to externalizing problems. _ese children were highly motivated to communicate with others, but their communication skills were so limited that they became frustrated and aggressive. _is study does not explain why frequency of request was a positive predictor of v-scale score for externalizing problems, but suggests that considering the context of requests could be useful for planning countermeasures for externalizing problems. Charlop-Christy et al.

(2002) reported that interventions with PECS reduced maladaptive behavior in children with ASD.

Training children with ASD to make appropriate requests may also reduce externalizing problems. It might be expected that internalizing problem is related to IJA-LL including alternate looking more closely than IJA-HL because poor eye-contact and poor social relations are included in the internalizing problems. However, a stepwise multiple regression showed that IJA-HL was a more unique predictor of internalizing problems than IJA-LL. Maladaptive behaviors of participants in this study were evaluated based on the subjective impressions of their caregivers, but our indices of early social-communication behaviors were evaluated objectively and quantitatively by direct behavior observation. Our results suggest that the behavior indices of IJA-HL based on direct observation might be useful as the behavioral signs of internalizing problems. IJA is related to motivation for sharing positive a_ect (Bakeman & Adamson, 1984). In particular, IJA-HL may better represent the core social motivation de_cits observed in children with ASD (Mundy & Gomes, 1998; Rogers, Hepburn, Stackhouse, & Wehner, 2003).

Internalizing problem may re_ect poor social motivation in children with ASD. Training social-communication skills and promoting social motivation might be necessary for reducing internalizing problems in — — Y. Nagai, T. Hinobayashi & T. Kanazawa 8 children with ASD. In addition, a stepwise multiple regression showed that positive a_ect expression was a negative predictor of both internalizing and externalizing problems. _is is consistent with the _nding that positive a_ect expression was negatively related to maladaptive behavior (Prizant et al., 2006). _ese results suggest that promoting the development of joint attention, which is required for sharing attention and emotions, may be important for reducing both externalizing and internalizing problems in children with ASD. However, few researchers have focused on positive a_ect expression with communication in children with ASD, and should be examined in future research. _is study investigated characteristics of early social-communication behaviors in children with ASD by directly observing behavior during free-play situations and showed that children with ASD displayed early social-communication behaviors less frequently than children with developmental disorders without ASD. In addition, this study demonstrated that di_erent types of early social-communication behaviors in_uence di_erent kinds of maladaptive behaviors in children with ASD. In particular, positive a_ect expression with communication was a negative predictor of both internalizing and externalizing problems. It is critical that we explore how maladaptive behaviors develop in children with ASD, with a particular focus on the development of early social ommunication.

It is hoped that the _ndings presented in this paper will contribute to a better understanding of special education and developmental support for children with ASD.

Future work should examine relationships between development of early social-communication and maladaptive behaviors in children with ASD a_er actual interventions.

**Acknowledgment**

_is study was supported by JSPS KAKENHI Grant Number JP14J00981. We are sincerely grateful to the children, their parents, and nursery sta_s of the child developmental support center who cooperated with this study. We thank Ms. Saki Maeda (Osaka University) and Ms. Kyoko Makita (Osaka University) for their valuable support.

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* Corresponding Author
Mailing Address: 1–2 Yamadaoka, Suita-shi, Osaka 565–0871,
Japan
E-mail Address: nagai5@hus.osaka-u.ac.jp
Received April 14, 2016, Accepted October 29, 2016
DOI: 10.6033/specialeducation.6.1

# Social-Emotional Behavior

Evidence-Based Complementary and Alternative Medicine
Volume 2011 (2011), Article ID 250708, 14 pages
http://dx.doi.org/10.1093/ecam/neq072

# GOOD STUDY

**Original Article**

# The Impact of Group Drumming on Social-Emotional Behavior in Low-Income Children

Ping Ho,1 Jennie C. I. Tsao,1 Lian Bloch,2 and Lonnie K. Zeltzer1

1Pediatric Pain Program, Department of Pediatrics, David Geffen School of Medicine, University of California, Los Angeles, USA

2Clinical Science Program, Department of Psychology, University of California, Berkeley, CA, USA

Received 10 August 2009; Accepted 19 May 2010



## Abstract

Low-income youth experience social-emotional problems linked to chronic stress that are exacerbated by lack of access to care. Drumming is a non-verbal, universal activity that builds upon a collectivistic aspect of diverse cultures and does not bear the stigma of therapy. A pretest-post-test non-equivalent control group design was used to assess the effects of 12 weeks of school counselor-led drumming on social-emotional behavior in two fifth-grade intervention classrooms versus two standard education control classrooms. The weekly intervention integrated rhythmic and group counseling activities to build skills, such as emotion management, focus and listening. The Teacher's Report Form was used to assess each of 101 participants (n = 54 experimental, n = 47 control, 90% Latino, 53.5% female, mean age 10.5 years, range 10–12 years). There was 100% retention. ANOVA testing showed that intervention classrooms improved significantly compared to the control group in broad-band scales (total problems ($P < .01$), internalizing problems ($P < .02$)), narrow-band syndrome scales (withdrawn/depression ($P < .02$), attention problems ($P < .01$), inattention subscale ($P < .001$)), Diagnostic and Statistical Manual of Mental Disorders-oriented scales (anxiety problems ($P < .01$), attention deficit/hyperactivity problems ($P < .01$), inattention subscale ($P < .001$), oppositional defiant problems ($P < .03$)), and other scales (post-traumatic stress problems ($P < .01$), sluggish cognitive tempo ($P < .001$)). Participation in group drumming led to significant improvements in multiple domains of social-emotional behavior. This sustainable intervention can

foster positive youth development and increase student-counselor interaction. These findings underscore the potential value of the arts as a therapeutic tool.

## 1. Introduction

Children under age 18 years represent a quarter of the total population of the USA (74 million) [1]; 39% are low-income, that is, living in families earning less than double the federal poverty level [2]. Although European Americans represent the largest number of low-income children (26%, 10.9 million), other groups are more disproportionately represented: Latino (61%, 9.4 million), African American (60%, 6.5 million), American Indian (57%, 0.3 million), Asian American (30%, 0.9 million), children of immigrant parents (58%, 7.4 million), children of native-born parents (35%, 20.2 million) [2].

### 1.1. Mental Health Needs of Low-Income Youth

Low-income youth are commonly exposed to stressors [3–12] that are well-established risk factors for behavior problems and school failure in the general youth population [13]. Correspondingly, socioeconomic disadvantage is associated with internalizing (e.g., depressive, anxious, somatizing, post-traumatic stress) and externalizing (e.g., antisocial, aggressive, delinquent, substance abusing) behavior in children and adolescents [3, 9, 14–22]. The burden of chronic stress held by low-income youth is compounded by poor access to health and mental health care [1, 22–26]. Moreover, low-income families may be reluctant to obtain services, for reasons ranging from stigma and attitude towards treatment [27, 28] to psychosocial and legal ramifications of reporting problems [12, 29, 30]. Minority youth, in particular, are at greater risk of encountering the “triple threat" of suboptimal health, lack of access to care and inferior services [26].

Notwithstanding, relatively few mental health interventions have targeted low-income youth, and most aim to reduce a single problem behavior or deficit [31–37] in contrast to a positive development approach of increasing core assets that may influence a range of problem behaviors [38, 39]. Positive youth development interventions facilitate positive outcomes through developmentally appropriate achievements intended to address the “whole child" [39].

### 1.2. Group Drumming for Positive Development, Cultural Relevance and Stress Reduction

Group drumming is a recreational music making activity that builds social-emotional assets consistent with a positive youth development approach. It is conducted in a circle and often led by a facilitator whose role is to maximize a sense of community through rhythmic dialogue. Group drumming is inclusive; it is non-verbal, universal, and does not require previous experience for participation. Furthermore, group drumming is culturally relevant; it is an integral part of diverse cultures, and supports the value of collectivism, shared by non-European-based cultures [40].

Previous studies of adults [41–43] and adolescents [44] have shown the biopsychosocial efficacy of group drumming, using protocols involving reflection and self-disclosure to reduce stress. These studies found neuroendocrine and immune changes that were indicative of reduced stress in normal adults with no previous experience in drumming [41], reduced burnout and improved mood in long-

term care workers and nurses [42, 43], and improved social-emotional functioning in adolescents from a court-referred residential treatment center [44]. Other art forms used in therapeutic contexts with adults and children have also been linked with improvement in biopsychosocial indicators of stress [45–62].

The unique effectiveness of group drumming with reflection and self-disclosure [41], versus group drumming without these components, suggests the possible added benefit of integrating counseling activities with group drumming to reduce social and emotional manifestations of stress in low-income youth. Social–emotional skill building delivered in a framework of drumming may also confer benefits without the stigma of therapy.

### 1.3. Theoretical Rationale

According to Social Cognitive Theory, group drumming combined with group counseling activities would foster individual self-efficacy and positive outcome expectations through enactive attainment, vicarious experience, verbal persuasion and reduction of physiological arousal [63]. Furthermore, collective efficacy may grow through a shared sense of purpose [63]. In support of this notion, Paulo Freire's Empowerment Education Theory of Dialogue and Praxis asserts that the development of empathy through common experience enables more meaningful reflection and dialogue, which in turn sets the stage for action, or empowerment [64, 65].

### 1.4. Research Objective

In summary, low-income youth are in need of interventions to address social and emotional behavior linked to chronic stress. Therefore, could a school-based group drumming program, integrated with activities from group counseling, improve social and emotional behavior in low-income children?

## 4. Discussion

This pilot study investigated the impact of group drumming on social-emotional behavior in low-income, primarily Latino, children with the specific aim of identifying the range of behaviors that may show improvement with intervention. The TRF was utilized to assess a myriad of problem behaviors. Students in the school counselor-led drumming program improved significantly compared to the control group in multiple domains of social-emotional behavior. Significant changes were found in broad-band scales (total problems and internalizing problems), narrow-band syndrome scales (withdrawn/depression, attention problems, and inattention subscale), DSM-oriented scales (anxiety problems, attention deficit/hyperactivity problems, inattention subscale, and oppositional defiant problems), and other scales (post-traumatic stress problems and sluggish cognitive tempo). On each of these scales, at least one drumming class did better than at least one control class. These findings support our hypothesis that a school-based group drumming program, integrated with activities from group counseling, would improve social and emotional behavior in low-income children.

### 4.1. Implications

The results of this study suggest that group drumming combined with group counseling may be used effectively to mitigate internalizing problems in a low-income, predominantly Latino, population. This is important not only because Latino youth tend to report more internalizing problems than other youth [74–76], but also because these types of problems are even difficult for their caregivers [77] and physicians [17] to identify. In addition, children manifesting behavior problems in the attention spectrum (including sluggish cognitive tempo, which can be a proxy for inattention) [78] seem to respond well to this intervention.

The effectiveness of the intervention appears to have been due to the combination of drumming and counseling activities, based on surveys of the teacher participants and anecdotal reports by the school counselor, observer, and students involved in the study. In support of this assumption, Bittman et al. evaluated six different protocols (resting control, listening to drumming music, 50% instruction and 50% drumming activity, 20% instruction and 80% drumming activity, facilitated shamanic drumming, and composite drumming involving reflection and self-disclosure facilitated specifically by a music therapist) and found that only the composite protocol led to neuroendocrine and immune changes in adults, at a level indicative of stress reduction [41].

The strength of this intervention was reflected in its effectiveness within a realistic school context [79]. In the name of sustainability, a school counselor was used to deliver the intervention, rather than an expert drum circle facilitator. Moreover, an entire classroom of a mixed composition of up to 30 students was served at a time, despite the fact that a stronger effect may have been achieved by working with groups of 10–15 students at a time [41, 42, 80, 81] or by delivering it only to those screened for critical levels of need [82–86]. In addition, implementation took place during the school day after lunch, which is a difficult time of day to teach based upon an informal survey of elementary school teachers. Finally, study participants were in their spring semester of fifth grade—the most challenging time of year for the most potentially resistant group of elementary school students.

The findings of this study are consistent with other school-based, short-term, group interventions aimed at improving behavior in low-income youth [80–82, 85, 87, 88]. Enhancing school-based services can reduce barriers to mental health care [89, 90], as they are the primary source of such care for youth [90, 91]. School settings are ideally suited for preventive services, extended observation, and coordinated care [89]. School counselor-led group drumming, as conceived in this study, not only expands these possibilities in culturally relevant ways but also offers an additional area in which students can excel. The intrinsic value of drumming, and the opportunity to develop competence in it, may lead to continued participation [92], which may in itself be helpful given the social, emotional and academic benefits that have been linked to participation in music activities [93] and organized activities in general [94]. The National Education Association calls for the use of the arts as a “hook" to get the growing number of Latino students interested in school [95]. School counselor-led group drumming can not only serve as the “hook" but also close an opportunity gap that exists for low-income youth [96, 97].

### 4.2. Limitations

Several methodological issues in this pilot feasibility study need to be considered, and future studies should attempt to address these limitations. First, the effect sizes in the current study ( = 0.09–0.23) were small due to the sample size and inclusionary approach to recruitment; however, one cannot underestimate the practical value of a change in behavior of even one student in a classroom [84]. Smaller gains across a broader distribution of risk factors may also have larger public health value [86, 98], particularly given variations in behavioral responses to stress based on race, ethnicity, and gender [18, 99–101]. Furthermore, achieving an effect under challenging circumstances may increase the value of the finding [79]. The effect sizes reported in this study are comparable to those found in meta-analyses of other interventions reported in the literature [36, 86, 102, 103].

Second, random assignment of classrooms to treatment conditions was not feasible due to school administrative constraints; however, selection bias was probably minimized by the homogeneity of the study population. Third, teacher raters were not blinded to the group assignment of the students and, thus, may have been prone to reporting bias; this is a major limitation of the pilot study. Future studies should include cross-informant measures or utilize objective observers in order to corroborate findings. Fourth, the lack of an attention control group [104] and the necessary inclusion of a “gifted" class in the experimental group may have had unintended effects.

Finally, this study demonstrated that a group drumming intervention could improve social-emotional indicators of stress; however, in order to identify stress reduction more definitively as the possible mechanism, corresponding biological indicators should be measured. Figure 12 shows neuroendocrine, neuroimmune, autonomic nervous system, and pain indicators of stress reduction that have been associated with arts-based interventions in the scientific literature [41, 45–47, 49, 51–54, 56–58, 60].

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Figure 12: Stress reduction as the proposed mediator between the drumming intervention and reduced internalizing and externalizing behavior.

### 4.3. Future Research

The results of this study suggest that future investigations linking group drumming and social-emotional behavior in a low-income, primarily Latino, population should focus on assessment of problems in internalizing and attention spectrum domains. However, future studies should also involve larger samples, analyzed for effects on different subgroups of youth by race, ethnicity and gender, as differences in intervention effects have been reported in each of these areas [35, 80, 81, 86, 87]. In order to determine the integrity of results over time, follow up assessments would be necessary. It would also be useful to assess the extent to which a sustained or repeated intervention could mitigate behavior problems—such as substance abuse, gang involvement, and school dropout—that are not typically seen at the elementary school level. Additionally, while this study has demonstrated the effectiveness of group drumming for improving social-emotional behavior in a normative sample, future studies should assess its potential utility in a clinical population. The participants in this study were a non-referred population that showed baseline scores at or below the norm in all behavior scales; therefore, clinical significance cannot be inferred despite the statistically significant reductions in problem behaviors reflected in these scales [4, 9, 18, 69].

Future research should also investigate the effects of the group drumming intervention on academic performance [105, 106], particularly given a meta-analysis of 300+ studies that found academic achievement and behavior significantly improved by social-emotional learning [107]. The study reported here did not utilize the academic performance portion of the TRF, in an effort to reduce the burden on teacher respondents. Additionally, family participation may enhance the effects of the intervention, since family support has been shown to buffer internalizing and externalizing behavior in low-income youth [19, 21, 101, 108–111]. Group drumming lends itself well to family involvement, without the stigma of a mental health intervention [27, 28]. Finally, future studies should evaluate the relative efficacy of intervention delivery by other types of school personnel.

## 5. Conclusions

School counselor-led group drumming, integrated with activities from group counseling, appears to improve the social and emotional correlates of chronic stress in low-income children. Through a positive development approach, the program can increase core assets that may influence a wide spectrum of behaviors, thus yielding broad public health value. This sustainable program can increase student-counselor interaction, provide a feasible alternative to traditional counseling methods that may lose efficacy over time, and serve as a portal to mental health care for those with unmet needs. The results of this study underscore the potential value of the arts as a therapeutic tool.

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# Social Interactions and Brain Cell Connections Brain cells rewire depending on social experiences.

Published on June 7, 2012 by Eugene Rubin, M.D., Ph.D. in Demystifying Psychiatry

Humans are social beings, and it shouldn’t be surprising that there are specific groups of nerve cells in the brain that are directly influenced by social experiences. One important mechanism mediating these interactions is neuroplasticity, which involves the brain’s ability to modify connections between various groups of brain cells. In essence, the brain can rewire itself and adjust the degree to which certain regions communicate with each other. Neurogenesis, i.e., the ability of certain brain regions to generate new neurons, is another important mechanism involved in some forms of neuroplasticity. The pattern of connections that form between new brain cells and older cells is a powerful way that the brain can change in response to social and environmental experiences, and some evidence indicates that the new brain cells exert important regulatory actions over stress responses. The process of neuroplasticity is critical to all aspects of brain function, including those involving cognition, memory, emotions, and motivation.

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“Social neuroscience” is a rapidly growing area of brain research that focuses on deciphering the mechanisms underlying interactions between interpersonal behavior and brain activity. Recently, the journal *Nature Neuroscience* published a series of review articles pertaining to

social neuroscience. Some of the information described in this post is based on one of these review articles: “Social influences on neuroplasticity: stress and interventions to promote well-being” by Richard Davidson and Bruce McEwen.

During the process of development, there are specific time periods (so-called “critical periods”) when exposure to certain stimuli is needed in order for normal brain function to develop. For example, if a child has a “lazy eye” and it isn’t discovered early in life, the unaffected eye becomes dominant and the “lazy” eye may not develop the ability to see adequately. If the condition is discovered early, then patching the good eye allows the “lazy” eye to develop better vision.The ability to correct this visual defect becomes more difficult with age as the time window closes on the critical period for visual development. In terms of social and emotional development in humans, the nature and timing of such “critical periods” hasn’t been clearly defined. However, there is evidence that interventions in very young children may be more effective in minimizing the long-term symptoms of certain disorders such as autism than intervening when a person is older. Determining the nature of critical periods that are relevant to specific forms of social and emotional development is an important area of current and future research.

Early childhood experiences can strongly influence a person’s long-term ability to interact with other people. Being exposed to highly stressful adverse events early in life can negatively impact how we handle stress and interact with others later in life. Genes play an important role in this adaptation, and some people inherit the ability to tolerate adverse circumstances better than others. Genes and environment are constantly interacting and shaping the brain’s ability to adjust. Interestingly, there is some evidence from research with squirrel monkeys that occasional mild stress in young animals has beneficial effects, increasing exploratory behaviors and independence as they mature.

Evidence from other animal studies indicates that chronic significant stressors can decrease the connections in brain regions involved in memory and higher order information processing, such as the hippocampus and prefrontal cortex. However, the same chronic stressors actually increase connectivity between cells in areas of brain involved in emotion, such as the amygdala and orbitofrontal cortex. Some of these regions also change their overall size in response to chronic stressors.

Importantly, certain positive interventions can help re-establish normal connections among these various brain regions following exposure to stress. Physical activity, environmental enrichment, and decreasing stress levels can all lead to a reversal of stress-induced changes in brain connections. Once again, exercise proves to be beneficial to our mental health. Voluntary exercise is also an interesting example of a form of controlled stress that can result in positive effects on both body and brain function.

Certain psychotherapies, for example, cognitive behavior therapy, can help people with illnesses such as depression or anxiety disorders. These therapies likely influence brain connections through learning and enhanced attentional processing. Anti-depressant medications also have been shown to reverse stress-induced connectivity changes in the hippocampus.

There are also certain medications that more directly influence the brain's ability to undergo neuroplasticity, and it is likely that new drugs will be developed that have specific effects on neuroplastic mechanisms. It is possible that therapies will be developed that specifically utilize neuroplasticity-altering medication during behavioral or psychotherapeutic sessions. Administering these medications concurrent with the therapy might enhance the effectiveness of the therapy in producing behavioral improvement. This is an area where much more research is needed, but early results with the drug D-cycloserine are encouraging.

Being able to modify neuroplastic changes in the brain and reverse abnormal patterns of connections has the potential to dramatically influence the ability to effectively treat persons with a variety of psychiatric illnesses. Such approaches may also be applicable to helping people whose brain wiring has been altered by addiction to various drugs.

This column was co-written by Eugene Rubin MD, PhD and Charles Zorumski MD.

# STRESS & MINDFULLNESS

Complementary Health
Practice Review
Volume 14 Number 1
January 2009 10-18

10.1177/1533210108329862
http://chpr.sagepub.com
hosted at http://online.sagepub.com

## Mindfulness Research

Update: 2008

Jeffrey M. Greeson, PhD, MS

Objective: To briefly review the effects of mindfulness on the mind, the brain, the body, and behavior. Methods: Selective review of MEDLINE, PsycINFO, and Google Scholar databases (2003–2008) using the terms ‘‘mindfulness,’’ ‘‘meditation,’’ ‘‘mental health,’’ ‘‘physical health,’’ ‘‘quality of life,’’ and ‘‘stress reduction.’’ A total of 52 exemplars of empirical and theoretical work were selected for review.

Results: Both basic and clinical research indicate that cultivating a more mindful way of being is associated with less emotional distress, more positive states of mind, and better quality of life. In addition, mindfulness practice can influence the brain, the autonomic nervous system, stress hormones, the immune system, and health behaviors, including eating, sleeping, and substance use, in salutary ways.

**Conclusion:** The application of cutting-edge technology toward understanding mindfulness— an ‘‘inner technology’’—is elucidating new ways in which attention, awareness, acceptance, and compassion may promote optimal health—in mind, body, relationships, and spirit.

**Keywords**: mindfulness; meditation; mental health; physical health; quality of life; stress reduction

### INTRODUCTION

There is rapidly accumulating evidence in the field of complementary health practices that greater mindfulness can not only reduce stress and stress-related medical symptoms but can also enhance positive emotions and quality of life. Moreover, studies are beginning to show a relationship between (a) how much people practice meditation, (b) how much more mindful they become, and (c) the positive effects they experience in terms of mental and physical health. This brief, selective review presents some of the most recent scientific

findings that demonstrate how practicing mindfulness meditation can affect the mind, the brain, the body, and behavior in ways that may promote whole-person health.

**RESULTS**

Mindfulness Meditation and the Mind Research on mindfulness supports the idea that cultivating greater attention, awareness, and acceptance through meditation practice is associated with lower levels of psychological distress, including less anxiety, depression, anger, and worry (cf. Baer, 2003; Brown, Ryan, & Creswell, 2007; Greeson & Brantley, 2008; Grossman, Niemann, Schmidt, & Walach, 2004). Furthermore, studies have begun to elucidate how mindfulness training can reduce distress. One observational study found that more time spent on formal meditation practices (body scan, yoga, sitting meditation) at home during an 8-week intervention led to increased mindfulness, which, in turn, explained decreased psychological distress and increased psychological well-being (Carmody & Baer, 2008). A recent randomized controlled trial (RCT) in students showed that 4 weeks of mindfulness meditation training, relative to somatic relaxation training or a nonintervention control group, reduced distress by decreasing rumination, a cognitive process associated with depression and other mood disorders (Jain et al., 2007). Another clinical study found that 8 weeks of mindfulness meditation training significantly reduced ruminative thinking in persons with a history of depression (Ramel, Goldin, Carmona, & McQuaid, 2004). Together, these studies indicate that one salutary mechanism of mindfulness appears to involve reshaping ways of thinking that engender improved emotional well-being.

Mindfulness scale development research has found that people with higher natural levels of mindfulness—irrespective of formal meditation training—report feeling less stressed, anxious, and depressed, and more joyful, inspired, grateful, hopeful, content, vital, and satisfied with life (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Brown & Ryan, 2003; Cardaciotto, Herbert, Forman, Moitra, & Farrow, 2008; Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007; Walach, Buchheld, Buttenmu¨ ller, Kleinknecht, & Schmidt, 2006). In addition to the mental health benefits of meditation practice and cultivating mindful awareness in daily life, simply being in a mindful state momentarily is associated with a greater sense of well-being (Lau et al., 2006).

Research further suggests that people with higher levels of mindfulness are better able to regulate their sense of well-being by virtue of greater emotional awareness, understanding, acceptance, and the ability to correct or repair unpleasant mood states (Baer et al., 2008; cf. Brown et al., 2007; Feldman et al., 2007). The ability to skillfully regulate one's internal emotional experience in the present moment may translate into good mental health long-term.

Finally, a number of different mindfulness-based training programs—including Mindfulness-Based Stress Reduction (MBSR), Mindfulness-Based Cognitive Therapy

(MBCT), Acceptance and Commitment Therapy (ACT), Dialectical Behavior Therapy(DBT), and Mindfulness-Based Eating Awareness Training (MB-EAT)—can effectively treat more serious mental health conditions, including anxiety disorders (MBSR; ACT), recurrent major depression (MBCT), chronic pain (MBSR; ACT), borderline personality disorder (DBT), and binge eating disorder (MB-EAT; Baer, 2006). Although additional well-designed studies using active control groups are needed to replicate and verify the mental health benefits of mindfulness meditation training (Toneatto & Nguyen, 2007), the body of evidence to date supports a relationship between cultivating a more mindful way of being on one hand, and a tendency to experience less emotional distress, more positive states of mind, and better overall quality of life on the other hand.

**Mindfulness Meditation and the Brain**

A number of studies have demonstrated that systematic mindfulness training as well as brief meditation practices in novices can influence areas of the brain involved in regulating attention, awareness, and emotion (cf. Cahn & Polich, 2006; Lutz, Slagter, Dunne, & Davidson, 2008b). One key element of mindfulness is the ability to pay attention to the present moment, on purpose (Kabat-Zinn, 2003). A recent clinical study found that 8 weeks of mindfulness meditation training (MBSR) led to an increased ability to orient one's attention to the present moment, as measured by a laboratory attention test (Jha, Krompinger, & Baime, 2007). Another experimental study found that compared with a relaxation training control group, 5 days of integrative meditation training—including mindfulness—significantly improved the efficiency of executive attention during a computerized attention test (Tang et al., 2007).

A second key element of mindfulness is the ability to recognize and accurately label emotions (Analayo, 2003). Brain imaging research has found that more mindful people appear to have a greater ability to control emotional reactions in the middle part of the brain (the amygdala and the dorsal anterior cingulate cortex [ACC]) by engaging the front part of the brain (the prefrontal cortex [PFC]), which is associated with attention, concentration, and emotion regulation (Creswell, Eisenberger, & Lieberman, 2008; Creswell, May, Eisenberger, & Lieberman, 2007). Another study found that employees in a corporate setting showed changes in front brain electrical activity (EEG) following 8 weeks of MBSR that were consistent with the experience of positive emotions like joy and content (Davidson et al., 2003).

A third key element of mindfulness is more refined self-awareness (Kabat-Zinn, 2003). One recent functional magnetic resonance imaging (MRI) study on this topic found that 8 weeks of MBSR was associated with greater neural activity in two brain regions believed to partially subserve self-awareness—the dorsolateral PFC and the medial PFC—during experiential and narrative self-focus tasks, respectively (Farb et al., 2007). A structural MRI study reported that experienced mindfulness meditators, relative to demographically

matched controls, had increased grey matter in brain regions that are typically activated during meditation, such as the right anterior insula, which subserves interoceptive awareness (Ho¨lzel et al., 2007a).

Researchers are also exploring the effect of specific meditation practices on the brain. For example, in adept meditators versus nonmeditators, mindful breathing practice (contrasted to mental arithmetic) was associated with increased rostral ACC and dorsomedial PFC activation, which may reflect stronger processing of distracting events and emotions, respectively (Ho¨ lzel et al., 2007b). Another functional brain imaging study found that practicing a brief loving kindness meditation activated regions of the brain associated with positive feelings toward others (Hutcherson, Seppala, & Gross, 2008). Loving kindness meditation—traditionally included as part of mindfulness training—is a contemplative practice designed to foster acceptance and compassion for oneself and others (Kabat-Zinn, 1990; The Dalai Lama, 2001). Finally, some studies suggest that greater meditation expertise is related to an increased ability to experience shifts in brain activity associated with positive emotions like compassion (Lutz, Brefczynski, Johnstone, & Davidson, 2008a).
Overall, it appears that focused, concentrative meditation practices can increase one's ability to maintain steady attention on a chosen object, like the breath or another person, whereas open awareness meditation practices can increase one's ability to flexibly monitor and redirect attention when it becomes distracted (Lutz et al., 2008b). Based on these findings, not only is it possible to train the mind to change the brain, but, in fact, one's ability to do so may get stronger as one gains meditation experience.

**Mindfulness Meditation and the Body**

There is increasing scientific evidence to support the therapeutic effect of mindfulness meditation training on stress-related medical conditions, including psoriasis (Kabat-Zinn et al., 1998), Type 2 diabetes (Rosenzweig et al., 2007), fibromyalgia (Grossman, Tiefenthaler-Gilmer, Raysz, & Kesper, 2007), rheumatoid arthritis (Pradhan et al., 2007; Zautra et al., 2008), chronic low back pain (Morone, Greco, & Weiner, 2008), and attention-deficit hyperactivity disorder (Zylowska et al., 2008). In addition, research has consistently shown that mindfulness training reduces symptoms of stress and negative mood states and increases emotional well-being and quality of life among persons with chronic illness (cf. Brown et al., 2007; Grossman et al., 2004; Ludwig & Kabat-Zinn, 2008; Shigaki, Glass, & Schopp, 2006). The use of mindfulness training in treating specific pain conditions, hypertension, myocardial ischemia, weight control, irritable bowel syndrome, insomnia, human immunodeficiency virus (HIV), and substance abuse is presently under investigation in research supported by the National Institutes of Health (Ludwig & Kabat-Zinn, 2008).

The beneficial physical effects of mindfulness training may occur, in part, by learning

how to better cope with the inevitable stresses of daily life and to remember that there is usually more right with the body than wrong. Theoretical models of mindfulness have endeavored to explain empirical observations of salutary effects by articulating the role of improved meta-cognitive skills, such as decentering (Teasdale et al., 2002) or reperceiving (Shapiro, Carlson, Astin, & Freedman, 2006), and adaptive coping processes, such as positive reappraisal (Garland, Gaylord, & Park, IN PRESS). It has specifically been postulated that mindfulness may preempt stress-related illness through a number of psychological, biological, and behavioral pathways, including (a) clarifying primary appraisal of stressors, (b) facilitating accurate secondary appraisal of stressor demands and coping resources, (c) mitigating dysfunctional coping styles, such as catastrophizing and ruminating, (d) enhancing adaptive coping processes, such as positive reappraisal, and (e) reducing distress and psychophysiological activation (Garland, 2007).

Cutting-edge laboratory research is beginning to reveal some of the biological pathways through which mindfulness training may positively affect physical health and healing processes.

For example, the 8-week MBSR study by Davidson and colleagues (2003) showed that individuals who had the largest shifts in frontal brain activity also had the strongest antibody responses to a flu vaccine. That study was the first to show that mindfulness training can change the brain and the immune system in a way that might bolster resistance to disease. More recent MBSR studies in people with serious medical conditions, including breast cancer, prostate cancer, and other types of cancer, have documented lower levels of cortisol—a primary stress hormone—and normalized immune function, measured by natural killer cell activity and pro-inflammatory cytokine levels (Carlson, Speca, Faris, & Patel, 2007; Witek-Janusek et al., 2008). Research on patients with HIV infection further indicates that MBSR may produce beneficial effects on the immune system, including increased natural killer cell activity—an important first line of defense against viral infection—as well as increased production of b-chemokines, molecules that block HIV from infecting healthy immune cells (Robinson, Mathews, & Witek-Janusek, 2003). A different study on adults with HIV infection suggested that MBSR may protect against the loss of ‘‘helper’’ T cells over time—a primary measure of HIV disease progression (Creswell, Myers, Cole, & Irwin, IN PRESS).

Initial laboratory studies suggest that mindfulness meditation practices can alter autonomic and neuroendocrine system functioning, both at rest and when stressed. For example, one RCT found that a mindful body scan meditation produced greater increases in parasympathetic nervous system activity, indexed by cardiac respiratory sinus arrhythmia (RSA), than progressive muscle relaxation—a standard relaxation training technique (Ditto, Eclache, & Goldman, 2006). Another RCT showed that 5 days of meditation training, including mindfulness, significantly reduced the cortisol response to acute mental stress relative to a relaxation training control group that did not receive mindfulness or meditation instruction (Tang et al., 2007). Finally, a third RCT found that adults who

reported home practice times above the median during a 6-week compassion meditation training program exhibited significantly lower stress-induced levels of negative emotion and inflammation (interleukin-6) postintervention compared with individuals below the home practice median, who did not differ from controls (Pace et al., IN PRESS). Taken together, these experimental studies indicate that mindfulness practices may promote health, in part, by attenuating stress reactivity and stimulating parasympathetic tone, perhaps more strongly than relaxation techniques.

**Mindfulness Meditation and Behavior**

Another key element of mindfulness is the cultivation of equanimity or nonreactivity. Specifically, mindfulness meditation teaches one to pay attention to and acknowledge both one's inner experience and the outer world, without necessarily reacting. The ability to simply observe and accurately sense thoughts, emotions, and physical sensations—without having to change them, or act on them—can be instrumental in breaking habitual behavior patterns that can harm one's health, such as smoking a cigarette when feeling stressed, eating comfort food when feeling sad or ''empty,'' or turning to alcohol or other substances to ''numb out'' when feeling overwhelmed. Promising findings from behavioral research suggest that mindfulness training may help people experience stress and negative emotions without acting impulsively and self-destructively in their attempt to self-sooth (cf. Brown et al., 2007). For example, some of the studies to date have found that people trained in mindfulness show a better ability to quit smoking (Davis, Fleming, Bonus, & Baker, 2007), decrease binge eating (Kristeller, Baer, & Quillian-Wolever, 2006), and reduce alcohol and illicit substance use (Bowen et al., 2006). At least one study has shown that reduced substance use following mindfulness training was partially explained by acceptance, rather than avoidance, of unwanted thoughts (Bowen, Witkiewitz, Dillworth, & Marlatt, 2007). Mindfulness may also promote better health, in part, by improving sleep quality, which can be disrupted by stress, anxiety, and difficulty turning off the mind (Winbush, Gross, & Kreitzer, 2007).

## CONCLUSION

The latest scientific research on mindfulness has demonstrated beneficial effects on several aspects of whole-person health, including the mind, the brain, the body, and behavior.

Clinical trials and laboratory studies alike suggest that the mechanisms of mindfulness involve not only relaxation, but important shifts in cognition, emotion, biology, and behavior that may work synergistically to improve health. There is also emerging evidence that mindfulness training is associated with greater meaning and peace in one's life (spirituality) as well as enhanced relationships with others (Carmody, Reed, Kristeller, & Merriam, 2008; Carson, Carson, Gil, & Baucom, 2004). A number of cutting-edge technologies, including brain imaging, are being used to examine the potential health

benefits of mindfulness, an ‘‘inner technology’’ we all possess. Finally, research is beginning to prove what mindfulness practitioners have known for centuries—that greater attention, awareness, acceptance, and compassion can facilitate more flexible, adaptive responses to stress, which, in turn, can help free us from suffering and realize greater health and well-being.

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Jeffrey M. Greeson, PhD, MS, is an Assistant Professor of Psychiatry & Behavioral sciences at the Duke University School of Medicine in Durham, North Carolina. Dr. Greeson currently works as a licensed psychologist and a clinical investigator at Duke Integrative Medicine, a leading center for the science and practice of whole-person health care. He recently received a career development award from the National Center for Complementary & Alternative Medicine (NCCAM) at the National Institutes of Health (NIH) to support his research on mindfulness, sleep quality, stress physiology, and cardiovascular risk reduction. Prior to his current appointment, Dr. Greeson completed a 2-year postdoctoral fellowship in Health Psychology at Duke Integrative Medicine. He holds a PhD in Clinical Health Psychology (University of Miami, 2006) and a Master's degree in Biomedical Chemistry (Thomas Jefferson University, 2001). As a clinician, Dr. Greeson specializes in integrating mind–body skills such as meditation and hypnosis with cognitive-behavioral therapy to help clients treat and prevent stress-related health problems—from obesity, high blood pressure, and chronic pain, to depression, anxiety, and insomnia. Dr. Greeson has conducted research in the fields of integrative medicine, mindfulness meditation, and stress physiology since 1998. His work has been recognized at national and international conferences, and his studies have been published in several peer-reviewed academic journals.

- MC3004979



Psychiatry Res. Author manuscript; available in PMC 2012 Jan 30.
Published in final edited form as:
Psychiatry Res. 2011 Jan 30; 191(1): 36–43.
Published online 2010 Nov 10. doi: 10.1016/j.pscychresns.2010.08.006
PMCID: PMC3004979
NIHMSID: NIHMS232587

# Mindfulness practice leads to increases in regional brain gray matter density

Britta K. Hölzel,[*,a,b] James Carmody,[c] Mark Vangel,[a] Christina Congleton,[a] Sita M. Yerramsetti,[a] Tim Gard,[a,b] and Sara W. Lazar[a]
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## Abstract

Therapeutic interventions that incorporate training in mindfulness meditation have become increasingly popular, but to date, little is known about neural mechanisms associated with these interventions. Mindfulness-Based Stress Reduction (MBSR), one of the most widely used mindfulness training programs, has been reported to produce positive effects on psychological well-being and to ameliorate symptoms of a number of disorders. Here, we report a controlled longitudinal study to investigate pre-post changes in brain gray matter concentration attributable to participation in an MBSR program. Anatomical MRI images from sixteen healthy, meditation-naïve participants were obtained before and after they underwent the eight-week program. Changes in gray matter concentration were investigated using voxel-based morphometry, and compared to a wait-list control group of 17 individuals. Analyses in *a priori* regions of interest confirmed increases in gray matter concentration within the left hippocampus. Whole brain analyses identified increases in the posterior cingulate cortex, the temporo-parietal junction, and the cerebellum in the MBSR group compared to the controls. The results suggest that participation in MBSR is associated with changes in gray matter concentration in brain regions involved in learning and memory processes, emotion regulation, self-referential processing, and perspective taking.

**Keywords:** meditation, mindfulness, voxel based morphometry, gray matter, longitudinal, hippocampus, posterior cingulate
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## 1. Introduction

Mindfulness meditation has been reported to produce positive effects on psychological well-being that extend beyond the time the individual is formally meditating. Over the last three decades mindfulness meditation practices have been increasingly incorporated into psychotherapeutic programs, to take advantage of these benefits (cf., Baer, 2003; Grossman et al., 2004). A large body of research has established the efficacy of these mindfulness-based interventions in reducing symptoms of a number of disorders, including anxiety (Roemer et al., 2008), depression (Teasdale et al., 2000), substance abuse (Bowen et al., 2006), eating disorders (Tapper et al., 2009), and chronic pain (Grossman et al., 2007), as well as improving well-being and quality of life (e.g., Carmody and Baer, 2008). Mindfulness meditation involves the development of awareness of present-moment experience with a compassionate, non-judgmental stance (Kabat-Zinn, 1990). It has been suggested that this process is associated with a perceptual shift (Carmody, 2009), in which one's thoughts and feelings are recognized as events occurring in the broader field of awareness.

Neuroimaging studies have begun to explore the neural mechanisms underlying mindfulness meditation practice with techniques such as EEG (Davidson et al., 2003; Slagter et al., 2007) and functional MRI (Farb et al., 2007; Lutz et al., 2008; Farb et al., 2010; Goldin and Gross, 2010). Recently, several cross-sectional anatomical MRI studies have demonstrated that experienced meditators exhibit a different gray matter morphometry in multiple brain regions when compared to non-meditating individuals (Lazar et al., 2005; Pagnoni and Cekic, 2007; Hölzel et al., 2008; Luders et al., 2009; Vestergaard-Poulsen et al., 2009; Grant et al., 2010;). While most of the brain regions identified have been reported in only one of these studies, the divergent results are likely due to differences in participant characteristics, type of meditation, and data analysis methods (see Table 1). Group differences in the hippocampus and the right anterior insula, however, have each been identified in at least two of the studies. Furthermore, activation in both regions has been reported during meditative states (hippocampus (Lazar et al., 2000; Hölzel et al., 2007); insula (Farb et al., 2007; Lutz et al., 2008)). The hippocampus is known to be critically involved in learning and memory processes (Squire, 1992), and in the modulation of emotional control (Corcoran et al., 2005; Milad et al., 2007), while the insula has been postulated to play a key role in the process of awareness (Craig, 2009) - functions which have been shown to be important in the process and outcomes of mindfulness training (Bishop et al., 2004; Shapiro et al., 2006; Ortner et al., 2007).

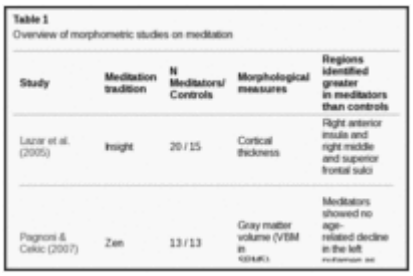

Table 1
Overview of morphometric studies on meditation

| Study | Meditation tradition | N Meditators/ Controls | Morphological measures | Regions identified greater in meditators than controls |
|---|---|---|---|---|
| Lazar et al. (2005) | Insight | 20 / 15 | Cortical thickness | Right anterior insula and right middle and superior frontal sulci |
| Pagnoni & Cekic (2007) | Zen | 13 / 13 | Gray matter volume (VBM in | Meditators showed no age-related decline in the left |

Table 1
Overview of morphometric studies on meditation

A growing body of literature has demonstrated that neural systems are modifiable networks and changes in the neural structure can occur in adults as a result of training. For example, longitudinal studies have shown task-specific increases in brain gray matter as an effect of acquisition of abstract information (Draganski et al., 2006), motor skills (Draganski et al., 2004), aerobic training (Colcombe et al., 2006), and cognitive skills (Ilg et al., 2008). Cross-sectional studies have established that differences in regional gray matter are associated with performance abilities (Mechelli et al., 2004; Milad et al., 2005), suggesting that an increase in gray matter corresponds to improved functioning in the relevant area. Studies of experienced meditators have also suggested the possibility of structural plasticity, but their cross-sectional designs did not exclude the possibility of pre-existing group differences, precluding causal conclusions. Here we report a longitudinal study of gray matter changes associated with a mindfulness-based intervention. The focus of the study was to identify brain regions that changed in association with participation in an eight-week Mindfulness-Based Stress Reduction course (MBSR; Kabat-Zinn, 1990). This group program aims to improve participants' mindfulness and well-being, and reduce their levels of perceived stress. The study was an attempt to find objectively measurable neurological changes that could underlie the trait-changes associated with mindfulness practice. Changes in gray matter concentration were investigated using voxel-based morphometry. Focused analyses were conducted for the hippocampus and insula as our predefined regions of interest. Exploratory analyses were then performed on the entire brain and compared to a control group.

# 4. Discussion

This study demonstrates longitudinal changes in brain gray matter concentration following an eight-week Mindfulness-Based Stress Reduction course compared to a control group. Hypothesized increases in gray matter concentration within the left hippocampus were confirmed. Exploratory whole brain analyses identified significant increases in gray matter concentration in the PCC, TPJ, and the cerebellum.

The hippocampus has been postulated to play a central role in mediating some of the benefits of meditation, due to its involvement in the modulation of cortical arousal and

responsiveness (Newberg and Iversen, 2003), and morphological differences between meditators and non-meditators in the hippocampus have previously been reported (Hölzel et al., 2008; Luders et al., 2009). The hippocampus also contributes to the regulation of emotion (Corcoran and Maren, 2001; Corcoran et al., 2005; Milad et al., 2007) and the structural changes in this area following mindfulness practice may reflect improved function in regulating emotional responding. In contrast to these increases, several pathological conditions (e.g., major depression (Sheline, 2000), post-traumatic stress disorder (Kasai et al., 2008)) are associated with decreased density or volume of the hippocampus. And while the precise mechanisms of hippocampal volume decrease are not known, a number of factors such as neuronal loss through chronic hypercortisolemia, glial cell loss, stress-induced reduction in neurotrophic factors, or stress-induced reduction in neurogenesis may contribute to this (Sheline, 2000). Furthermore, smaller hippocampi have also been shown to constitute a risk factor for the development of stress-related psychopathology (Gilbertson et al., 2002). However, the hippocampus is a region well known for its ability to remodel synapses and generate new neurons (Gage, 2002), and volume loss in this region seems to be reversible (Gould et al., 2000; Jacobs et al., 2000). For example, treatment with selective serotonin reuptake inhibitors – aside from improvement of stress disorder symptoms - has been found to lead to an increase in hippocampal volume (Vermetten et al., 2003) and it has been suggested that some of the behavioral effects of antidepressant treatment might depend on neurogenesis in the hippocampus (Santarelli et al., 2003). Future research will be needed to investigate whether similar neural mechanisms contribute to improvements in mental health following a medication-free behavioral intervention. We previously reported that changes in perceived stress were correlated with structural changes in the amygdala in a study that included subjects in the present study, and changes in stress were not correlated with changes in the hippocampus (Hölzel et al., 2009). However, the structural changes in the hippocampus identified here might be related to improvements in one of the other well-being-related variables that have been reported to improve following participation in an MBSR course.

The insula is known to be impacted in interoceptive/visceral awareness (Critchley et al., 2004) as well as in empathic responses (Singer et al., 2004). More generally, a recent review points to the fundamental role of the insula in human awareness, or consciousness (Craig, 2009). Given that mindfulness meditation constitutes training in interoception and conscious awareness, and based on the findings of previous studies which described functional as well as morphological differences in the insula between meditators and non-meditators (Hölzel et al., 2008; Lazar et al., 2005; Lutz et al., 2008), we hypothesized structural increases in the current study. However, the Pre-Post comparison within the MBSR group was not significant. It is possible that greater amounts of practice are required to produce structural changes in this region. It is also possible that previously identified differences between meditators and non-meditators were unrelated to the meditation training, but rather pre-existing. Furthermore, a recent study revealed that meditators did

not show superior performance in an interoceptive task (Khalsa et al., 2008), challenging the assumption that enhanced cortical thickness and functional activation in the insula in meditators are related to better interoceptive awareness. Future studies that include a longer training program and assess interoceptive awareness Pre and Post intervention could help address these contradictory findings.

It has been suggested that the TPJ is a crucial structure for the conscious experience of the self, mediating spatial unity of self and body (Blanke et al., 2005), or embodiment (Arzy et al., 2006), and impaired processing at the TPJ may lead to the pathological experience of the self, such as disembodiment or out-of-body experiences (Blanke et al., 2005). Furthermore, the TPJ is also involved in social cognition, i.e., the ability to infer states such as desires, intentions, and goals of other people (Van Overwalle, 2009) and there is evidence of greater activation of this region during feelings of compassion in meditators (Lutz et al., 2008). Mindfulness training involves both the establishment of an awareness of oneself as a 'complete whole' (Kabat-Zinn, 1990), and the cultivation of compassion. The morphological changes in the TPJ might be associated with increases in compassion attributed to meditation training (Shapiro et al., 2005) and the cultivation of an embodied self.

Correspondingly, several studies suggest that the PCC is engaged when assessing the relevance or significance of a stimulus for oneself (Gusnard, 2001; Schmitz and Johnson, 2007) and it has been suggested to be particularly important for the integration of self-referential stimuli in the emotional and autobiographical context of one's own person (Northoff and Bermpohl, 2004). These functions also are closely related to mindfulness practice, which involves the introspective observation of phenomenal experiences as they are encountered (Kabat-Zinn, 1990). Structural increases might be related to the repeated activation of this region during this process. Interestingly, the hippocampus, TPJ, and PCC (as well as parts of the medial prefrontal cortex not identified in the present study) form a brain network (Vincent et al., 2006) that supports diverse forms of self-projection (Buckner and Carroll, 2007), including remembering the past, thinking about the future (Schacter et al., 2007), and conceiving the viewpoint of others (Saxe and Kanwisher, 2003). These abilities have been suggested to share a common set of processes, by which autobiographical information is used adaptively to enable the perception of alternative perspectives (Buckner and Carroll, 2007). Literature on the mechanisms of mindfulness proposes that the positive benefits of the practice might be mediated by a perceptual shift that modulates the internal representation of the self (Shapiro et al., 2006; Carmody, 2009) and it is possible that structural changes in the brain network involved in the projection of oneself into another perspective may underlie this perceptual shift.

One of the two extensive clusters identified in the cerebellum was located in lateral parts of the posterior and flocculonodular lobe and the other one was located in the vermis, reaching into the brainstem. Aside from the well-known function of the cerebellum in the integration of sensory perception, coordination, and motor control (Marr, 1969), this

structure also plays a crucial role in the regulation of emotion and cognition. Lesions of the cerebellum have been found to lead to a constellation of cognitive, affective and behavioral abnormalities, the so-called "cerebellar cognitive affective syndrome" (Schmahmann et al., 2007). It has been suggested that in the same way that the cerebellum regulates the rate, force, rhythm, and accuracy of movements, it also regulates the speed, capacity, consistency, and appropriateness of cognitive and emotional processes (Schmahmann, 2004), i.e., it modulates behavior automatically around a homeostatic baseline. Given the importance that the regulation of emotions and cognition play in healthy psychological functioning, the morphological changes in these regions might contribute to the positive effects of mindfulness meditation on the salutary changes in well-being.

Regions within the brainstem were found to increase in gray matter concentration over the eight weeks. These regions appear to include the area of the locus coeruleus, nucleus raphe pontis, pontine tegmentum, and the sensory trigeminal nucleus (Naidlich et al., 2009). The regions of gray matter differences between meditators and non-meditators in the cerebellum and brainstem identified by Vestergaard-Poulsen et al. (Vestergaard-Poulsen et al., 2009) do not appear to overlap with the ones identified here. The locus coeruleus is the site of synthesis and release of the neurotransmitter norephinephrine, while the raphe nuclei release serotonin. The modulation of the serotonin system has been profoundly effective for the treatment of a wide range of mood and anxiety disorders, as evidenced by the widespread use of SSRIs (Masand and Gupta, 1999). The norephinephrine system of the locus coeruleus is thought to optimize behavioral performance by modulating arousal, regulating the interplay between focused vs. flexible responding to environmental demands, or selective vs. scanning attention (Aston-Jones et al., 2000; Aston-Jones and Cohen, 2005). Considerable evidence exists that the neurons of this system are important in a variety of cognitive, affective, and other behavioral functions, as well as associated clinical dysfunctions (e.g., depression, anxiety, sleep, and circadian disorders; for discussion, see (Aston-Jones, 2002). It is also one of the primary sites for the mediation of the stress response as well as a site of action of antidepressant drugs (Brady, 1994). Several studies have documented the positive impact of mindfulness-based programs on symptoms of anxiety and depression (Baer, 2003; Kuyken et al., 2008; Roemer et al., 2008), as well as improvements in sleep patterns (Carlson and Garland, 2005; Ong et al., 2009) and attention (Jha et al., 2007). The morphological changes reported here might contribute to some of these enhancements.

While significant Pre-Post changes in the TPJ, PCC, and cerebellum have been found in the present study, it is unclear why previous cross-sectional studies of meditators have not identified group differences in these regions. It is possible that small differences existed but were not detected due to the lack of power in the previous small cross-sectional studies, or that structural changes are transient and change might be maximal when a skill is newly acquired (Driemeyer et al., 2008).

It should be noted also that MBSR is a multifaceted group program and some positive effects may result from components not specific to meditation or mindfulness, such as group social interaction, stress education, or gentle stretching exercises. Exercise is know to increase neurogenesis in the hippocampus (van Praag et al., 1999). Since it also plays a crucial role in long-term memory consolidation and learning, structural changes might be related to general learning that occurred during the MBSR course analogous to those found in a study of medical students learning new information (Draganski et al., 2006). Comparing the brain gray matter concentration changes in the MBSR group to those of a waitlist control group, the current study did not allow differentiating between the effects of these different components. Indeed, the absence of a positive correlation between the change in gray matter concentration and the amount of homework suggests that the number of minutes of formal homework exercise are not the primary driving force behind the effects, but that the MBSR program as a whole influences the morphological changes. Future studies employing an active control condition that includes the mindfulness-unspecific components of the program (e.g., MacCoon et al., 2008) would help isolate the specific effects of meditation. Also, the current study investigated physician- and self-referred individuals seeking stress reduction and generalizations should therefore be limited to this population of stress individuals. Future studies will be required to test whether findings extend to non-stressed individuals as well as individuals suffering from mental disorders. Finally, the current study employed a rather small sample size and replication is necessary.

The adult nervous system has the capacity for plasticity, and the structure of the brain can change in response to training (Gage, 2002; Draganski et al., 2004; Colcombe et al., 2006; Driemeyer et al., 2008). It is generally assumed that the increased gray matter results from repeated activation of a brain region (May et al., 2007; Ilg et al., 2008) and previous studies have shown activation during meditation in brain regions identified here (Lou et al., 1999; Lazar et al., 2000; Newberg et al., 2001; Hölzel et al., 2007; Lutz et al., 2008). The cellular mechanisms underlying training-induced neuroanatomical plasticity are not yet understood however. An extensive body of research during the last decade has established that MBSR leads to improvements in psychological health and well-being (Grossman et al., 2004; Carmody et al., 2009). Demonstrating morphological increases in regions associated with mental health, the data presented here suggest a plausible underlying neural mechanism, namely, that such increases represent enduring changes in brain structure that could support improved mental functioning. Knowledge of the neurobiological mechanisms of behavioral interventions is indispensable to their effective and targeted use.

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# Acknowledgement

We thank our participants for their cooperation and the Center for Mindfulness for conducting the Mindfulness-based stress reduction courses. We thank Daniel McCaffrey and Nik Olendzki for support in data collection, and Douglas Greve, Ulrich Ott, and Julie Bates for helpful discussions. This research was funded by the National Institutes of Health-NCCAM (R21-AT003425-01A2), the British Broadcasting Company, and the Mind and Life Institute (Varela research grant). B.K.H. was supported by a Marie Curie International Outgoing Fellowship within the 7th European Community Framework Programme. S.W.L. was supported by National Institutes of Health funding K01AT00694. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The authors declare no conflicts of interest.


# Footnotes



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# Mindfulness meditation improves cognition: evidence of brief mental training.

Zeidan F[1], Johnson SK, Diamond BJ, David Z, Goolkasian P.

## Author information

## Abstract

Although research has found that long-term mindfulness meditation practice promotes executive functioning and the ability to sustain attention, the effects of brief mindfulness meditation training have not been fully explored. We examined whether brief meditation training affects cognition and mood when compared to an active control group. After four sessions of either meditation training or listening to a recorded book, participants with no prior meditation experience were assessed with measures of mood, verbal fluency, visual coding, and working memory. Both interventions were effective at improving mood but only brief meditation training reduced fatigue, anxiety, and increased mindfulness. Moreover, brief mindfulness training significantly improved visuo-spatial processing, working memory, and executive functioning. Our findings suggest that 4days of meditation training can enhance the ability to sustain attention; benefits that have previously been reported with long-term meditators.



PMID:
20363650
[PubMed - indexed for MEDLINE]

http://www.ncbi.nlm.nih.gov/pubmed/20363650

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**Brain and Cognition xxx (2013) xxx–xxx**
**Contents lists available at SciVerse ScienceDirect**
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# Emotion regulation through execution, observation, and imagery of emotional movements

Tal Shafir [a,b,⇑], Stephan F. Taylor [a], Anthony P. Atkinson [c], Scott A. Langenecker [d], Jon-Kar Zubieta [a]
[a] Department of Psychiatry, University of Michigan, Ann Arbor, MI, USA
[b] The Graduate School of Creative Art Therapies, University of Haifa, Haifa, Israel
[c] Department of Psychology, Durham University, Science Laboratories, Durham DHI 3LE, United Kingdom
[d] Department of Psychiatry, University of Illinois at Chicago, IL, USA

**Keywords:**
Body expression of emotion, Nonverbal behavior, Emotion regulation; Embodiment Simulation Motor imagery

## a b s t r a c t
According to Damasio's somatic marker hypothesis, emotions are generated by conveying the current state of the body to the brain through interoceptive and proprioceptive afferent input. The resulting brain activation patterns represent unconscious emotions and correlate with subjective feelings. This proposition implies a corollary that the deliberate control of motor behavior could regulate feelings. We tested this possibility, hypothesizing that engaging in movements associated with a certain emotion would enhance that emotion and/or the corresponding valence. Furthermore, because motor imagery and observation are thought to activate the same mirror-neuron network engaged during motor execution, they might also activate the same emotional processing circuits, leading to similar emotional effects. Therefore, we measured the effects of motor execution, motor imagery and observation of whole-body dynamic expressions of emotions (happiness, sadness, fear) on affective state. All three tasks enhanced the corresponding affective state, indicating their potential to regulate emotions.


### 1. Introduction
Watching Charlie Chaplin acting in silent movies, we can easily comprehend his emotions based on his body language. Most people consider body language as the external manifestation of internal emotions through posture and movements. However, it has been suggested that the reversed process, i.e., that postures and movements can affect emotional state, is also true. This concept is based on Darwin's ideas and the James-Lange theory, which at their extreme, propose that bodily responses to stimuli are necessary

for emotional experience, and feelings are not the causes of autonomic system activation and emotional behavior, but rather are the consequence of these. Thus, we feel angry because we strike and afraid because we tremble, and not that we strike or tremble because we are angry or fearful (James, 1884).

In recent years, this theory has been re-formulated in neurophysiological terms by Antonio Damasio. According to Damasio, the current state of the body is conveyed to the brain through the processes of proprioception (afferent input representing muscle length and joint angle) and interoception (afferent input representing the physiological (e.g., thermal, metabolic) status of all body tissues), which create in the brain unique neural activation patterns. These neural activation patterns represent unconscious emotions that guide behavior and influence decisions, and they correlate with the conscious feelings of those emotions (Damasio, 1999; Damasio et al., 2000). The uncovering of neuronal underpinnings of interoception (Craig, 2002; Critchley, 2005) and the identification of anterior insular cortex as the brain region in which representation of internal bodily states becomes available to conscious awareness (Craig, 2009), provide plausible neurocircuits in support of this proposition. One important implication of Damasio's proposition is the potential to regulate one's feelings through deliberate control of motor behavior and its consequent proprioception and interception (Riskind, 1984). Thus, by engaging in movements that are associated with a certain emotion, one should be able to generate or enhance that emotion and its corresponding feelings. Could we really get happier by skipping like a kid or sense fear when shrinking and retreating?

The effects of facial expression on corresponding affective state have been widely studied (for review see McIntosh, 1996) and smiling is now used in dialectical behavioral therapy as a behavioral intervention for mood regulation. Evidence suggesting that the effects of facial expressions on affective states are attained through proprioception come from studies suggesting that changes in proprioceptive feedback from facial expressions following botulinum toxin treatment may weaken emotional experience (Davis, Senghas, Brandt, & Ochsner, 2010) and attenuate neural activation in the amygdala (Hennenlotter et al., 2009). Surprisingly, although progressive muscle relaxation is widely used for tension reduction (and has scientific support: Vancampfort et al., 2011) and dance has been used for centuries to intensify joy in social settings, evidence for the impact of emotional bodily posture and movements on affective state is scarce. A handful of studies have shown that isometric arm flexion (associated with approach, e.g., bringing food towards one's mouth) and arm extension (associated with rejection) affect evaluative cognitive processing, causing ubjects, for example, to rate neutral novel stimuli more positively during arm flexion than during arm extension (Cacioppo, Priester, & Berntson, 1993). A few other studies have shown that assuming certain postures (e.g., upright, slumped, expansive) immediately induce corresponding feelings (pride, sadness, power, respectively) (Carney, Cuddy, & Yap, 2010; Duclos, Laird, Schneider, & Sexter, 1989; Riskind & Gotay, 1982; Stepper & Strack, 1993), and thatinhibition of specific facial and motor behaviors reduce the corresponding feelings (Duclos & Laird, 2001). Moreover, holding for 2 min a posture that expresses power not only increased feelings of power, but also resulted in physiological responses: reduced cortisol

and increased testosterone (Carney et al., 2010), and combining facial expressions with matching expressive bodily postures resulted in corresponding feelings which lasted several minutes after stopping these behaviors (Schnall & Laird, 2003), and were stronger than engaging in either the facial expressions or postures alone (Flack, Laird, & Cavallaro, 1999).

We live in a dynamic world, where people's behavior is constantly modified to adjust to continuous changes in the environment. Thus, it is possible that engaging in whole-body dynamic movements which are associated with specific emotions (emotional movements) might have stronger effects on affective state than static postures, as it is more closely related to the ecological context in which emotion is experienced. Moreover, because brain response to unchanging stimuli diminishes over time due to neuronal adaptation, the consistently changing proprioceptive input from dynamic movements might create a stronger effect than the constant, unchanged proprioceptive input from a static posture. Indeed, perception of dynamic compared to static whole-body expressions of anger resulted in better recognition and stronger and more widespread emotion-specific brain activation (Pichon, de Gelder, & Grezes, 2008). Yet, to date, only one study has investigated the effects of whole-body emotional movements upon affective state (Duclos & Laird, 2001), and it was limited to movements designed to elicit only negative emotions. The first aim of our study was to examine the effects of engaging in emotional movements upon affective state, in particular, happy movements. We hypothesized that emotional movements would enhance corresponding affective state. We were especially interested to test whether happy movements could enhance positive feelings, because such novel finding might serve as a basis for developing a new, specific-movement based, emotion-regulation intervention for mood enhancement. Additional aims were to explore whether observation and imagery of emotional movements could also influence affective state.

It is now well established that observation of movements activates the same neural network that is active during execution of those same movements (i.e., the mirror neuron network). This mechanism of shared representations for perception and action of body and facial movements was proposed as the basis for action recognition (Rizzolatti, Fogassi, & Gallese, 2001), emotion recognition, and empathy (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Gallese, Keysers, & Rizzolatti, 2004). Both animal (Raos, Evangeliou, & Savaki, 2007) and human (Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard, 2006) studies have suggested that movement observation simulates in the brain the neural motor commands used to initiate execution of the same movement. It has also been suggested that neural motor commands for a given movement generate in the brain an internal representation of the expected proprioceptive feedback from that movement (Christensen et al., 2010; Raos et al., 2007; Sommer &Wurtz, 2008), and that emotions such as disgust or pain can be induced not only by afferent input from the body, but also by brain simulation of that afferent input (Bastiaansen, Thioux, & Keysers, 2009). Thus, it is very likely that simulation of the expected proprioceptive input from an emotional movement can induce the corresponding emotion during observation of such movement, similar to its induction by real proprioceptive input during motor execution. Support for this idea comes from both monkey (Raos et al., 2007) and human (Gazzola & Keysers, 2009) studies that found regions in the somatosensory cortex which were activated during both the execution and observation of the same action. Other studies found that observing movements which

express different emotions generated differential brain activation patterns in emotional processing regions (Peelen, Atkinson, Andersson, & Vuilleumier, 2007; Pichon, de Gelder, & Grèzes, 2009). In addition, observing emotional facial expressions caused subjects to experience the same emotions expressed by the stimuli (Lundqvist & Dimberg, 1995), with more intense expressions producing more intense feelings (Wild, Erb, & Bartels, 2001). Thus, we hypothesized that not only motor execution, but also observation of emotional movements would induce their corresponding feelings. Such emotion regulation effects of motor observation might be useful when actual motor execution is not feasible, and motor imagery could have a similar emotional response. Several studies have shown that kinesthetic motor imagery (i.e., imagining oneself doing a movement) results in activation of motor circuits similar to their activation during motor execution (Decety & Grèzes, 2006), and that brain activation underlying motor execution and motor imagery differ primarily in inhibition processes that suppress motor output during imagery (Lotze et al., 1999). Motor imagery has been shown to elicit autonomic responses and sensory experience that are directly associated with the imagined movements (Decety, Jeannerod, Durozard, & Baverel, 1993; Naito et al., 2002), and Schwoebel et al. have suggested that motor imagery involves generation of the expected proprioceptive input from the imagined movement (Schwoebel, Boronat, & Branch Coslett, 2002). Moreover, Kim et al. found that imagery of emotional facial expressions elicited activation in the amygdala (Kim et al., 2007). We therefore hypothesized that similar to observation, imagery of emotional movements would also enhance the corresponding affective state.

In this study we measured the effects of motor execution, observation, and kinesthetic motor imagery of happy, sad, fearful, and emotionally neutral movements on affective state, in order to explore their potential for therapeutic application. We hypothesized that all three modalities of whole-body emotional movements will enhance corresponding affective state.

## 2. Materials and methods

### 2.1. Participants

Twenty-nine participants were recruited for the study. After giving informed consent, participants were screened using the Movement Imagery Questionnaire-Revised Scale (MIQ-RS) (Gregg, Hall, & Butler, 2007) and the Expression Manipulation Procedure (Duclos & Laird, 2001). The MIQ-RS assesses the ability and ease of motor imagery. Only subjects who scored >70, indicating adequate motor imagery ability, continued their participation in the study. The Expression Manipulation Procedure determines the extent to which people are focused on, and are emotionally affected by their own bodies and actions (personal cues), as opposed to social expectations (situational cues). Only participants who scored >10, indicating a personal trait of sufficient sensitivity to their bodily cues of emotion, continued the study. Five participants were found ineligible by the Expression Manipulation Procedure and one by the MIQ-RS. One additional subject withdrew due to difficulties learning the movements. Thus, 22 healthy adults (11 males, 11 females; mean age = 25.4 years, SD = 6.15) completed the study protocol. All had no history of neurological or psychiatric disease, and were not taking any medications. All procedures were approved by University of Michigan Institutional Review Board.

### 2.2. Stimuli

For motor execution, each participant was taught to perform four sequences of emotional movements: one happy, one sad, one fearful and one neutral. The movement sequences were modeled from short (3 s), grey scale movie clips of dynamic wholebody expressions of emotions and emotionally neutral actions such as bending forward to touch one's toes. Movie clips were taken from a validated set (Atkinson, Dittrich, Gemmell, & Young, 2004) which included ten different motor sequences expressing each emotion (40 total). All movements in the clips were presented on a black background, and were performed by males and females actors who wore uniform dark grey, tight-fitting clothes and headwear, so that facial expressions were not visible (see Fig. 1).

Because different people express emotions in slightly different ways, we decided to use several different movement sequences to express each emotion. Thus, out of ten different clips available for each emotion, the four best recognized were taught to the subjects so that for each emotion, two stimuli expressing that emotion were each taught to five subjects and another two stimuli expressing the same emotion were each taught to six subjects. Stimuli assignment was random, but all male participants learned movements acted in the clips by male actors, and all female participants learned movements acted by female actors. For motor imagery subjects imagined themselves (kinesthetic imagery) moving the same motor sequences that they learned to execute. During the observation task, for each emotion subjects watched all available stimuli for that emotion, except for the stimulus that consisted of the motor sequence that they had learned to perform.

### 2.3. Design and procedures

The study had a within subject design and each subject performed all three tasks: motor execution, observation, and imagery of all four emotional movements. Testing took place in three sessions, separated by 1–7 (mean = 3) days from each other. During the first session, participants were taught by an experienced dance teacher the four emotional motor sequences in the order in which they were later tested. Subjects were told that the purpose of the study was to examine the effects of specific muscle activation patterns on brain function, and motor sequences were not identified as emotional, but were labeled with random letters, which were used during the second session as the cue prompting for motor execution and imagery of each sequence. Subjects' training, using dance-teaching methodology, lasted 1–1.5 h, until both subject and teacher judged that the subject could perform the movements easily and accurately. Motor training of the sequences was followed by kinesthetic-imagery practice of the same movements.

To ensure and enhance memory of the learned motor sequences, participants were asked to practice those sequences behaviorally and using imagery, for a few minutes each day in between testing sessions. The second experimental session began with a short rehearsal of the learned movements, followed by testing motor execution, observation, and imagery effects. Before and after motor execution of each motor sequence, subjects performed a memory test of short lists of words (to disguise the purpose of the study), and they rated their physical tiredness/fatigue, muscle soreness, and affective state, using the PANAS (Positive and Negative Affect Schedule) (Crawford & Henry, 2004) and visual analog scales (16.5 cm line) for eight different emotions (to disguise which emotion we were

interested in). Similar procedures were used to measure the effects on affective state of motor imagery and observation (see Fig. 2).

During motor execution, each sequence was performed in six blocks of six consecutive repetitions, with a few seconds rest in between blocks. Since each movement lasted about 3 s plus 0.5 s to return to the starting position, block duration was approximately 21 s.
The structure and duration of the observation and imagery tasks were based on the execution task, and they each included six blocks. In each observation block (21 s long), six different clips

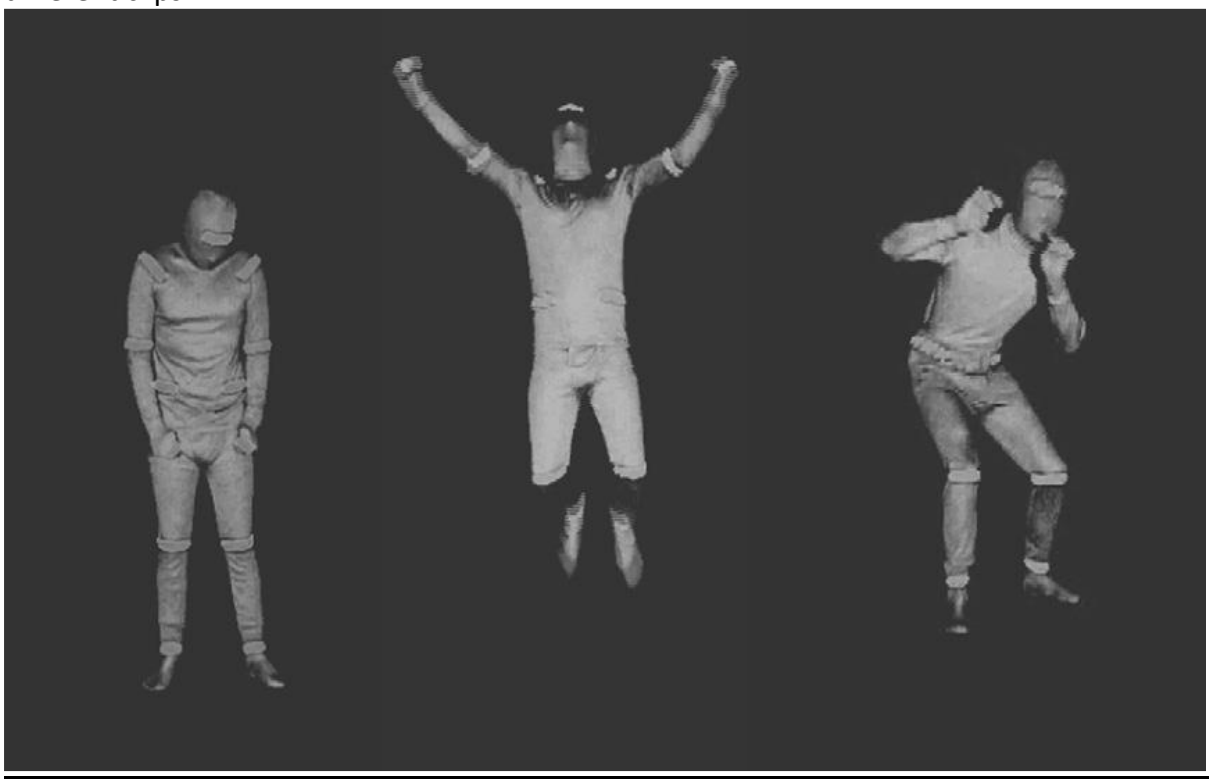

Fig. 1. Snapshots from the emotional movements stimuli. Pictures created from the video clips that were used in this study, by freezing each short movie in the middle of the
movement. The left picture was produced from a sad movement, the middle from a happy movement (a jump) and the right picture from a fearful movement.

**CARRIE – I COULD NOT COPY THE FIGURE**

Fig. 2. Experimental design. Example of experimental design of the second testing session for a representative subject. All subjects performed the motor execution task first.
Half the subjects performed the motor observation task second and the motor imagery task third (as in this example), and half of the subjects performed the motor imagery second and the motor observation third. The order of the three emotional movements types (happy (H), sad (S), fearful (F)) within each task was randomized across subjects, but the neutral movements (N) were always the last. Each task was consisted of six blocks with a few seconds of rest in between blocks, and each block included six consecutive motor sequences. A memory test and physical fatigue, muscle soreness, and affective ratings were performed at the times represented by each of the downward pointing arrows.

(3 s each) expressing the same emotion were shown, separated by 0.5 s of a cross sign. In some blocks, one or two of the clips repeated themselves. At the end of each block subjects

were asked how many clips were repeated in that block. This design was employed to ensure that subjects paid attention to the movies. Motor imagery task consisted of six blocks of 21 s each, during which subjects were asked to imagine themselves performing repeatedly the sequence associated with the prompting letter. Because the experimenter could not know whether subjects indeed imagined themselves moving, to encourage subject to comply, after each block subjects were asked to rate the difficulty of motor imagery during that block.

All subjects performed the motor execution task first. Order of motor observation and motor imagery tasks was randomized and balanced across subjects. Order of emotional movements within each task was randomized and balanced across subjects, but the neutral movements were always the last, so that each new task would start from a neutral affective state. Order of emotions within each task stayed the same in all tasks for each subject. Subjects were videotaped during motor execution for later validation of the similarity of their movements to those in the modeled clip. During the third testing session subjects were asked to identify the emotion expressed in each clip (forced choice) and to rate theintensity of that emotion on a scale of 1–7.

**2.4. Data analysis**

To ensure that subjects executed the motor sequences correctly and that their performance was not compromised by physical fatigue, we compared their movements during representative sequences: the first motor sequence of the sixth (last) block of each type of emotional movements, with the movements in the corresponding original clips. To do that we extracted from the subject's video short clips that included those representative motor sequences, and employed the EyesWeb software (Camurri, Lagerlöf, & Volpe, 2003) (http//www.infomus.dist.unige.it/), to obtain a 'Quantity of Motion' (QoM) value for each movie frame in the original stimulus clips and in the clips of the subjects performing those sequences. The EyesWeb software converts the body image into a 'Silhouette Motion Image (SMI)', which carries information about variation in the shape and position of the body silhouette across a moving window of a few frames (we used four) throughout the length of the movie. A QoM value, equivalent to the number of pixels of the SMI, was computed for each movie frame that this window moved across, and served as an estimate of the overall amount of detected motion. Since the duration of subjects' sequences (3.095 ± 0.339 s) was not always exactly 3 s (the original clip duration), we either interpolated or deleted data points from each subject's clip, in order to have the same number of data points (90) as in the original clip. We then correlated the QoM values from each subject clip to those from the corresponding original clip, as a measure of the similarity between the two motor sequences.

Emotion recognition (using arcsine-transformed proportion of correctly recognized clips of each emotion, to make the outcome normally distributed) and emotional intensity ratings of the happy, sad, fearful and neutral stimuli clips were compared using one-way repeated measure ANOVA, followed by pairwise comparisons corrected for multiple comparisons. Even though we hypothesized that all three tasks: motor execution, motor observation, and kinesthetic imagery, would enhance the corresponding affect using a similar process involving internal representations of the expected afferent feedback, these three tasks are inherently different: observation in contrast to execution and imagery entails the additional differentiation between self and others, and imagery differs from execution and

observation since under normal circumstances imagination and reality are not confused. In addition, several studies suggested that even within the mirror neurons network, brain activation during the three tasks is not completely identical. Differences have been found in activation magnitude (Raos et al., 2007), connectivity (Gao, Duan, & Chen, 2011), and some non-overlapping activation within the circuits that mediate the shared representations (Decety & Grèzes, 2006). Lastly, while during motor execution and imagery, subjects in our study continuously repeated one emotional motor sequence as a representative for each emotion, during the observation task they observed nine different motor sequences representing each emotion. Thus, one cannot compare the effects of one task to those of the other tasks, and separate analyses were performed for each task.

The effects of motor execution, observation and imagery of each type of emotional movements were therefore assessed with 1-tail paired t-tests, calculating separately for each emotional movement type within each task, the difference in affective score between post- and pre-task performance. For each emotional movement type, only the relevant affective ratings that were hypothesized to increase as a result of that movement were analyzed. These included the ratings of happiness and PANAS positive-summaryscore (PANASp) to assess the effects of happy movements, the ratings of sadness and PANAS negative-summary-score (PANASn) to assess the effects of sad movements, the ratings of fear and PANASn to assess the effects of fearful movements, and the rating of neutral/not feeling any specific emotion, to assess the effects of neutral movements. Because the effects of each type of emotional movements (happy, sad, fearful) within each task were tested on two different emotional ratings, the results were corrected for these two multiple comparisons.

In addition to the paired t-tests described above, we also examined within each task for each affective rating measure, whether the effect of the relevant emotional movements on that affective rating was significantly different from the effect of the neutral movements on that affective rating. For example: whether during motor execution, the effects of happy movements on PANASp were significantly different from (greater than) the effects of neutral movements on PANASp. We examined these differences using post hoc comparisons from a repeated measures ANOVA analysis that we performed for each affective rating measure. The ANOVA included the factors: task, emotional movement type, and task by emotional movement interaction, and Bonferroni adjustment was used to correct for the multiple post hoc tests.

## 3. Results

Subjects executed the emotional motor sequences very similarly to the original validated ones (Atkinson et al., 2004). Fourteen out of 22 subjects (63%) achieved the strict criteria of significant correlations between frame-by-frame QoM during their movements and frame-by-frame QoM during the corresponding original clips, for 75% or more of their analyzed representative movements.

Ratings of each clip during the third session indicated that all emotions were recognized at above 89% correct (fear: 95%, happiness: 90%, neutral: 89%, sadness 91%). Repeated measures ANOVA showed no significant difference in recognition accuracy between emotions. Nonetheless, there was a significant difference between emotions in their rated intensity (Wilks's $K = 0.23$, $F(3,19) = 21.66$, $p < 0.01$). The perceived emotional intensity of all emotional movements was significantly higher than that of the neutral movements.

In addition, the perceived intensity of the happy movements (5.25) was significantly higher than that of the fear (4.85) and neutral (3.61) movements, but not different from that of the sad movements (5.12).
When rating the stimulus clips at the end of the study, four participants did not rate the supposedly happy motor sequence that they performed and imagined as happy, two participants did not rate the supposedly fearful sequence that they performed and imagined as fearful, and one participant did not rate the supposedly neutral sequence that he performed and imagined as neutral. We therefore performed the paired t-tests that examined the effects of motor execution and motor imagery for these emotions twice: once including all subjects in the analysis, and once excluding from each analysis those subjects who did not recognize correctly the emotional movement whose effects were tested. We found that both types of analyses generated very similar results and we therefore report only the results from the t-tests that included all subjects in the analysis. Because each block in the observation task included several different clips, we could not separate the response to correctly recognized clips from that to incorrectly recognized clips. Thus all subjects and all blocks were included in the analyses of the observation task.
The paired t-tests revealed that motor execution of happy movements significantly increased positive affect, as measured by the PANAS positive affect ratings (PANASp) ($t(21) = 3.06$, $p = 0.003$). Execution of sad movements significantly increased the ratings of feeling sad ($t(21) = 3.72$, $p < 0.001$). Execution of fearful movements significantly increased negative affect, as measured by the PANAS negative affect (PANASn) ($t(21) = 2.43$, $p = 0.012$), and execution of neutral movements significantly increased neutral feelings, i.e., the ratings in the visual analog scale of feeling 'neutral'/not feeling any other specific emotion ($t(21) = 2.39$, $p = 0.026$) (see Fig. 3).

Observation of happy movements had no significant effects on affective state, but observing sad movements significantly increased sadness ($t(21) = 3.72$, $p < 0.001$). Observing fearful movements significantly increased fear ($t(21) = 2.29$, $p = 0.016$) and observation of neutral movements significantly increased neutral feelings ($t(20) = 2.66$, $p = 0.015$). Motor imagery of happy movements had no significant effects. Imagery of sad movements significantly increased sadness ($t(21) = 3.0$, $p = 0.0035$), and imagery of fearful movements significantly increased fear ($t(21) = 2.35$, $p = 0.0145$).

Considering the significant effects of observation and imagery of sad and fearful movements on the corresponding feelings, and the significant effect of motor execution of happy movements on positive affect, the finding that observation and imagery of happy movements had no significant effects was unexpected. One possible explanation for the lack of observation and imagery effects on positive affect might be that after reporting their emotions several times during the motor execution condition, participants might have become tired of completing questionnaires, and therefore started reporting less positive affect. To test this hypothesis of an order effect of fatigue on ratings, we compared the mean difference

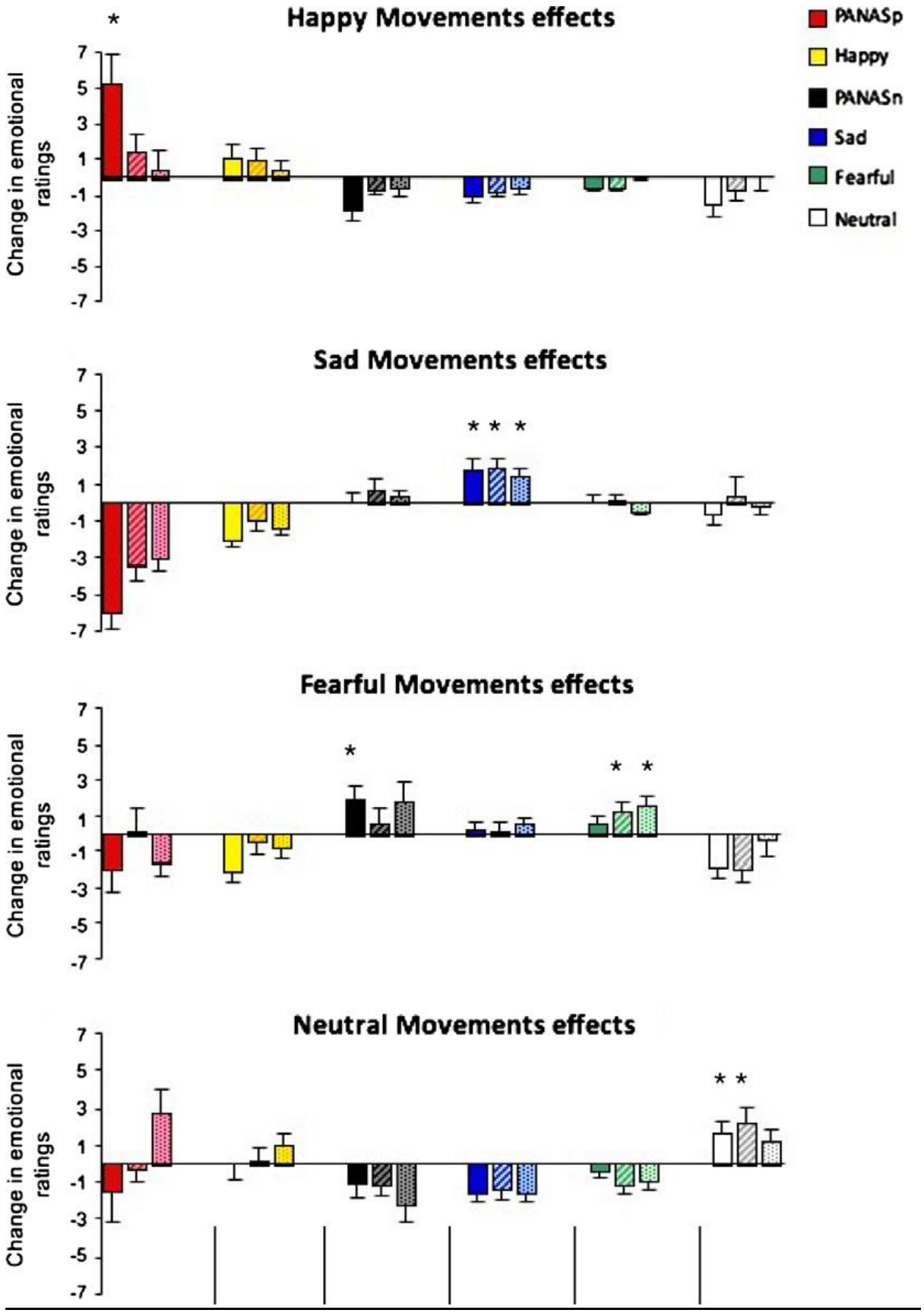


Fig. 3. Impact of emotional movements on affective state. Mean differences (changes) in affective ratings between post- and pre-task performance are presented to illustrate

the effects of happy, sad, fearful and neutral movements on affective state. The effects of each type of emotional movements is presented in a separate graph. Within each graph, the effects of motor execution (E; solid bars), observation (O; striped bars) and kinesthetic imagery (I; dotted bars) of the emotional motor sequence on each affective rating measure is presented. For each emotional movement type, we present its effects on six different affective ratings: The positive summary score of the Positive and Negative Affect Schedule (PANASp), the level of happiness as measured by the visual analog scale, the negative summary score of the Positive and Negative Affect Schedule (PANASn), and the levels of sadness, fear, and no specific emotions/neutral feelings, as measured by the visual analog scale. Although all six affective ratings measures are presented, each emotional movement was hypothesized and tested only for its effects on the two affective measures which were relevant to that movement, and the neutral movement was tested and hypothesized to affect only the rating of feeling neutral/no specific emotion. Units are based on visual analog scores for the affective ratings, and error bars represent ±1SE.

in positive affect between pre- and post-observation and imagery of happy movements, in those subjects who performed the observation task before the imagery task with those who performed the observation task after the imagery task. We found that the difference in PANASp between pre- and post-observation of happy movements was significantly higher in those subjects who performed the observation task third compared to those who performed the observation task second ($t(20) = \_3.396$), $p = 0.003$). A similar analysis for the difference in PANASp between before and after the imagery task revealed no significant difference between those subjects who performed the imagery task second and those who performed it third ($t(14) = \_0.388$, $p = 0.704$). These results ruled out an order/fatigue effect.

The post hoc comparisons from the ANOVA analyses, which examined the effects of task by emotional-movement interaction on each affective rating measure, revealed that during motor execution the effect of happy movements on positive affect (measured by PANASp) was significantly greater than the effect of the neutral movements on positive affect ($t(231) = 3.194$, $p = 0.010$), and the effect of sad movements on sadness was significantly greater than the effect of neutral movements on sadness ($t(231) = 4.735$, $p < 0.001$). During motor observation, the effect of sad movements on sadness was significantly greater than the effect of neutral movements on sadness ($t(231) = 4.610$, $p < 0.001$), and the effect of fearful movements on fear was significantly greater than the effect of neutral movements on fear ($t(231) = 5.009$, $p < 0.001$). During motor imagery, the effect of sad movements on sad feelings was significantly greater than the effect of the neutral movements on sad feelings ($t(231) = 4.103$, $p < 0.001$). Likewise, the effect of fearful movements on fear was significantly greater than the effect of neutral movements on fear ($t(231) = 3.909$, $p = 0.001$).

**4. Discussion**

Our purpose in this study was to evaluate whether motor execution of emotional ovements, in particular happy movements, could enhance corresponding affective state, and could therefore be used as a means for emotion regulation. We further exploredwhether similar effects could be obtained also by observation and imagery of the same movements. We found that all three tasks enhanced the corresponding affective state, indicating their

potential to regulate emotions and raising the possibility that emotional movements may have therapeutic applications.

As hypothesized, motor execution of happy movements significantly increased positive affect, indicating the potential for using execution of these movements as a method for mood enhancement.

In contrast to the effects of happy movements, execution of fearful movements significantly increased negative affect, indicating that the enhancement of positive affect following happymovements execution was not due to the increased amount of physical activity per se, but due to the specific qualities of the happy movement, i.e., the specific muscle activation pattern and joints angle configuration which characterize those movements. Moreover, execution of sad movements enhanced sad feelings, suggesting that particular movements may enhance not only the same affective valence, but also a more specific corresponding emotion.

The capability of execution of specific movements to enhance corresponding affect was further corroborated by the finding that execution of emotionally neutral movements increased neutral feelings, and the findings that compared to neutral movements, execution of happy movements significantly increased positive affect, while execution of sad movements significantly increased sadness.

Our results further suggest that feelings might be altered not only by active execution of certain movements, but also by stopping and/or avoiding other movements. Although we had no hypotheses regarding the effects of each type of emotional movement on non-corresponding emotions, we explored these effects by calculating the difference in those non-corresponding emotional ratings between post- and pre-task performance. Those differences are displayed in Fig. 3. Without specific hypothesistesting we cannot draw any unequivocal conclusion. Nevertheless, the performance of sad movements was associated with a considerable reduction in positive affect and happy feelings, which suggest that sad movements might diminish happiness and therefore positive mood might be enhanced not only directly by executing happy movements, but also indirectly by consciously avoiding sad body expressions. As hypothesized, observation and motor imagery of sad and fearful movements significantly enhanced corresponding feelings. These effects were further confirmed by comparing the affective changes following these respective emotional movements to those following the neutral movements. Observation and imagery of happy movements, however, did not produce such results. One possible explanation for the lack of observation and imagery effects on positive affect might be an order effect of fatigue on ratings, which might have caused the subjects to report less positive affect during motor observation and imagery, since they always followed motor execution. We tested this hypothesis and the results ruled out such an order/fatigue effect. Another possible explanation might be that the lack of observation and imagery effects of happy movements might have been caused by a ceiling effect in affective state. Our emotionally-healthy subjects had a positive baseline affective state, and the hypothesized neural signal of the simulated expected proprioceptive feedback during imagery and observation might have been too weak to increase positive affect even more. This was in contrast to motor execution, where the additional real proprioceptive feedback from the muscles and joints might have been strong enough to cause an effect. Support for this hypothesis comes from Raos et al. who found twice as much activation in the monkey's forelimb somatosensory cortex during motor execution compared to motor observation. Raoset al. suggested that

the higher level of activity observed in the sensory cortex during action execution might have reflected the anticipated sensory consequence of the movement (based on efference copy from the motor cortex) and the actual afferent feedback (signal from the muscles), whereas the 50% lower activity observed during action observation might have reflected the anticipated consequence of the movement only (Raos et al., 2007). If this explanation is true, then the neural signal from observation and imagery of happy movements might be strong enough to enhance affective state when the individual's baseline mood is negative, such as during depression. This proposition will have to be tested in future studies. Observation of neutral movements significantly increased neutral feelings as hypothesized, but imagery of neutral movements seemed to increase positive feelings more than neutral feelings. Kinesthetic motor imagery is not a simple task and the more experience and motor memory one has of a certain movement, the easier it is to imagine oneself doing it. The neutral movements were the simplest and easiest to learn and perform accurately, and might have caused the subjects to feel more successful in accomplishing the imagery task, thus producing positive affect during imagery. In sum, our results suggest that apart from a couple of exceptions (which might have a sensible explanation), observation and imagery of emotional movements tend to induce the corresponding affective state, suggesting that our hypothesis regarding simulation of afferent input as the underlying mechanism might be correct.

In a recent paper, Gallese and Sinigaglia have proposed that embodied simulation using the mirror neuron system might be one of the mechanisms underlying social cognition. They suggested that during mirror mechanismdriven embodied simulation, people reuse their own mental states or processes involving representations that have bodily format, and functionally attribute them to others (Gallese & Sinigaglia, 2011). In line with this view, here we suggest (as explained in the introduction), that during motor observation and imagery, the simulation (representation) of the sensory input which is expected to be generated by the observed or imagined movement, produces the corresponding emotion and affective state. This emotion could then be ''reused'' to understand the other's affective state and to emotionally empathize with her, by attributing that emotion to the observed other. To the best of our knowledge, this is the first time where observation and imagery of whole body movements have been shown to induce emotions and enhance corresponding affective state. This emotion induction by motor observation and motor imagery supports Gallese and Sinigaglia's idea regarding the role of embodied simulation in social cognition.

One limitation of our study was that task order was not completely balanced and motor execution effects were always tested first. This design was chosen in order to give the subjects an additional opportunity to experience the movements before they had to imagine them, so that kinesthetic imagery would be easier. This strategy also mimics what would typically be used in training and practice. This strategy should be more, not less, likely to enhance the impact of imagery. Another limitation was that we could not control for subject compliance during imagery, and the evaluation of imagery ability was based on subjective report. Additional limitation was that given the repeated surveys of emotion, the subjects may have responded to demand characteristics of the study and judged their emotion based on what they anticipated (consciously or unconsciously) the experimenter expected. This is a common problem for studies involving subjective report of emotion and difficult to fully exclude. We believe this confound was relatively minimized by our use of a cover story and word-recognition task to mask the purpose of the study. In addition, in order to disguise which emotions we were interested in, we asked the subjects

to rate a variety of emotions. Lastly, evaluation of the effects on physiological responses such as cortisol secretion or heart rate in addition to the subjective affective ratings would have strengthened our results. However, these physiological measures may be affected by engagement in the physical activity per se, and there are no existing tools that enable to distinguish the relative contribution of the quantity vs. quality of movements to physiological responses following the different emotional movements.
Clinical applications of our findings are potentially numerous. Happy movements could be used as activities in behavioral activation, and for positive mood induction in mood disorders and/or other circumstances or conditions in which mood might be affected (e.g., Parkinson's disease). To induce the desired mood, patients could either execute those movements, or if their motor abilities are limited, they could watch and imagine themselves doing the movements. Emotional movements could also be used during dance-movement therapy sessions to either evoke specific emotions in patients through motor execution, or to help the therapist feel and understand the patient's affective state by either mirroring the patient's movements, or observing and imagining herself doing the same movements. The effects of emotional movements might be further enhanced by accompanying the movements with appropriate corresponding music (Murrock & Higgins, 2009), and this hypothesis will have to be investigated in future studies. Future studies should also discern which motor elements (e.g., the body part that moves, movement speed, movement direction, movement size, etc.) characterize and are common to all emotional movements which are associated with, and enhance a specific emotion. This knowledge will enable to personalize the emotional movements used by eac each patient to enhance a specific affective state, based on his/her movement style and ability, without lessening the effectiveness of the movements. Our results indicate that only about 2 min of moving happy movements significantly increase positive affect. Future studies will investigate the duration of the effects of emotional movements on affective state, and will generate the knowledge required to determine effective dosage and prescription guidelines.

**5. Conclusions**

In summary, our study demonstrates that motor execution, observation and imagery of whole body emotional movements can enhance the corresponding affective state, and could therefore be used to assist in regulation of one's own emotions and recognition of others' emotions. In addition, our finding that observation and imagery of whole body emotional expressions can enhance corresponding affective state supports the notion of embodied simulation as a plausible mechanism underlying emotion recognition and empathy. Role of the funding source

This work was supported by the Phil F. Jenkins Foundation and Grant UL1RR024986 from the National Center for Research Resources. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Center for Research Resources or the National Institutes of Health.

Acknowledgments

We thank John Thoresen and Lisong Ni for their help with the EyesWeb 'QoM' analysis, and Heng Wang for his excellent wideranging technical assistance. We are also grateful to the study participants and to Mark Everson, Dave Hsu, Kristine Konz, Janna Kryscynski, Gahl Liberzon, Brian Mickey, Steve Reily, Preeti Samudra and Sara Weisenbach for volunteering their time and feedback during the development of the experimental and motor-sequence

teaching procedures.

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# Effects of multisensory yoga on behavior in a male child with Apert and Asperger syndrome

Michaela L Scroggins, Lyn G Litchke[1], Ting Liu[1]
JK-Fitness, San Antonio, [1]Department of Health and Human Performance, Texas State University, San Marcos, TX, USA
**Address for correspondence:** Ms. Michaela Scroggins,
12701 West Avenue, Apartment #1233, San Antonio, TX 78216, USA.
E-mail: michaelascroggins@gmail.com

## Official Publication of Swami Vivekananda Yoga Anusandhana Samsthana University

Volume 9 | Issue 1 | January-June | 2016

**Contents**

**ISSN 0973-6131**



**ABSTRACT**

This case focused on a 7-year-old boy with Apert and Asperger's syndrome who attended 8, 45 min multisensory yoga sessions, twice a week, during 4-week camp. Results from the pre- and post-tests on Treatment and Research Institute for Autism Social Skills Assessment showed improvements in the total score changes from 19 to 7 for disruptive behaviors. Sparks Target Behavior Checklist scores changed from eight to one showing progression in ability to stay on task. Yoga Pose Rating Scale displayed the transformation in total scores from 80 = emerging to 115 = consistency in pose performance. The field notes revealed the positive development in expressive emotions, social engagement, and decline in looking around. Outside class parent and school behavioral specialist reported the improved ability to self-regulate stress using lion's breath and super
brain. These findings indicate an improvement in behaviors that influenced the physical performance, emotional expression, and social interaction after yoga training for this child.

**Key words:** Apert syndrome; Asperger syndrome; behavior; multisensory yoga; social skills.

## INTRODUCTION

Apert syndrome is a rare genetic disorder characterized by physical abnormalities in the skull, acromegaly, difficulty with speech, and low intelligence quotient. Apert research predominately explores the surgical procedures, indicating a lack of studies on effective therapies.[1] Asperger's syndrome, representing 75% of children diagnosed with autism spectrum disorder (ASD), is characterized by low muscle tone, restricted social skills, unusual mannerisms, and interests. Yet, only 5% of funds in the USA are dedicated to ASD research.[2] Yoga research for children with ASD has demonstrated improvements in

stillness, following directions, emotional expression, and social interaction.[3-10] There were no studies found on Apert syndrome and yoga.

## CASE REPORT

A 7-year-old male (pseudonym Tom) presented with Apert and Asperger's Syndrome exhibiting the characteristics of difficulty following directions, lack of emotions, irritability, shyness, and poor coordination. In addition, his unusual mannerisms of looking around frequently impaired his engagement with yoga program. Looking around was characterized by his gazing off in the distance or up at ceiling. Tom attended 8, 45 min multisensory enriched yoga, twice a week, during a 4-week camp for children with ASD.

The study was approved by Institutional Review Board of local university, and parental consent was obtained during the camp enrolment. Throughout the entire day camp, Tom was partnered with a college counselor to assist with any needs. Thirty-one poses were performed in a small group of five males. Multisensory enrichment aspect included singing of familiar children's songs, counting, rhythmic gesture chanting, and a personalized yoga bin containing yoga colored picture binder, cut outs of hands and feet, feather, pinwheel, small flashlight, bean bag animal, and a large towel. Each multisensory feature was goal oriented based on his diagnosis. For example, the binder contained illustrations and instructions of each pose in sequential order to compliment all learning styles; a pinwheel and feather were used during the breathing exercises to promote calmness and focus; repetitive rhythmic chants and clapping were added to increase vocalization and engagement; singing the familiar children's songs aided time on task and improving language; towel placed over the body in ragdoll to promote tranquility; a miniature flashlight was used during call-repeat mantra to emphasize "light within" to focus on self-awareness.

Yoga pose samples are presented in Table 1.

The pre- and post-test measures of behavior, social skills, and physical pose performance were obtained from Sparks Target Behavior Checklist (STBC; measured 59 on task and interactive behaviors using a dichotomous scale: Yes = 1 and no = 0),[11] Treatment and Research Institute for ASD Social Skills Assessment (TRIAD; measured 18 problematic behaviors on a Likert scale from 0 = never to 4 = consistent),[12] Yoga Pose Rating Scale (YPRS; rated 31 poses on Likert scale: 1 = rarely to 5 = mastery),[8] and field notes (FN; rated four multidimensional quality of life domains). All four forms were completed by trained yoga instructor based on a video recording of yoga. Finally, Tom's parent and school ehavior specialist were asked to comment on any changes noted at the end of sessions.

Results of YPRS showed the overall total score change from 80 = emerging (partial body engagement) to 115 = consistently (whole body engagement) indicating he held poses more accurately for a longer period of time.

TRIAD depicted improvement in the total score from 19 to 7, indicating less disruptive behaviors specifically in shyness and unusual mannerism of looking around. STBC illustrated the elimination of seven out of eight behaviors in the area of staying on task; all that remained was the behavior of looking around. The results of FN indicated that Tom initially was disengaged, shy, rejected help, frequently looked around, and was unexpressive emotionally. He was able to transition to seeking help appropriately, expressing emotions such as laughter and smiling, spending less time looking around, and taking on a leadership

role for last yoga session. By a report from behavior school specialist and parent, he also improved his timely utilization of lion's breath and super brain as a means to self-regulate during stressful situations outside the yoga.

## DISCUSSION

This case demonstrated the positive impact of multisensory enriched yoga on behaviors that influenced the physical performance, emotional expression, and social interaction for this young male. Changes in behaviors were observed during Tom's physical yoga pose performance scores most notably in cat/cow, down dog, reverse warrior, seated forward fold, and call-and-repeat mantra. According to FN, his balance and coordination of upper and lower extremities in poses improved along with his imitation of animal behaviors and sounds. He also utilized the cut outs

**Table 1:** Sample yoga poses

| Yoga poses | Instructions | Benefits | Equipment and Cues* |
|---|---|---|---|
| Chanting and breath series<br>Pinwheel breath work | The participants were asked: "Grab the pinwheel out of your bin, inhale through the nose and on the exhale blow on the pinwheel" (repeat 3 times) | Promotes calmness, and stilling the mind; adding the pinwheel promotes engagement and focus | 18" pinwheel |
| Lions breath | From a kneeling position, participants were instructed: "Inhale through the nose raising up high on your knees with your hands raised like lions paws, and then exhale and roar like a lion while sticking your tongue out. Lower back down to your knees and place their hands back on the ground" (repeat 3 times) | Reduces stress, mild depression, and anxiety | "ROAR like a LION!" |
| Balance series<br>Tree | The participants were verbally cued to chant the familiar child song. Then "stand with feet shoulder width apart and place your foot on your calf, or inner thigh." Repeat 1 time on other side beginning with the song | Calms the mind, cultivates poise, and focus | Sing prior to pose while clapping your hands "if you are happy, and you know it, be a tree; again on the other side" (repeat song) |
| Airplane | The participants were guided: "Bend at the hips and bring one leg back perpendicular to the floor. Place your arms straight out to the side horizontally." Repeat 1 time on other side | Improves balance, develops concentration, and strengthens legs, chest, and arms | Sing while holding pose: "Fly like airplane, fly like airplane, fly like an airplane in the sky; again on the other side (repeat song) |

| | | | |
|---|---|---|---|
| Flexibility series<br>Table top<br>pose | The participants are asked: "Get your beanbag toy out of the bin. Lay down on your back. Place the toy on your stomach to aid with balance. Then, inhale, while rising up on your hands with hips in the air. Then, exhale and slowly lower bodies back to mat (repeat 3 times) | Stretches pelvis, chest, and shoulders; aligns spine, strengthens bones; increases coordination and balance | Animal beanbag toy is place on<br>the stomach |
| *Each participant had a plastic bin with equipment and picture book of poses | | | |
| | | | |
| | | | |
| | | | |

of hands and feet, towel, and camp counselor partner to lengthen the time in pose and form proper body alignment [Figure 1]. Our findings are similar to Radhakrishna[8] and Radhakrishna *et al*.[9] who not only utilized a partner model during yoga, but also noted an improvement in imitationof poses and vocalization of sounds.Researchers on the role of yoga in children with ASD haveshown a transfer of positive emotional coping behaviors from yoga to school and home.[3,4,6,8] For example, Ehleringer discovered children with ASD were able to generalize their ability to self-regulate emotions from yoga to other life areas.[3] Specific to benefits of the super brain, Koterba's found a positive impact on increased focus, decreased self-stimulation, and improved social skills. [7] Tom was able to utilize lions breath and super brain [Figure 2] to calm himself down in stressful situations outside of yoga as reported by school behavior specialist and parent.

One of the most paramount developments was Tom's transformation in social behaviors from shy and withdrawn to a confident leader. For example, Tom went from being irritable and rejecting assistance to asking his camp counselor appropriately for help to stabilize himself in poses. During the last yoga class, Tom accepted the instructor's offer to lead and demonstrate poses in front of the other children [Figure 3]. Another researcher Kenny observed the improvements in connecting with partners during yoga and emphasizing the need for instructors to create opportunities for children with ASD to lead or demonstrate poses for the class.[5] Moreover, Radhakrishna *et al*. noted that children moved closer to the instructor and showed a more positive mood.[9] While his looking around remained his unusual behavior, it lessoned from occurring frequently to very rarely interfering with yoga engagement. This could have resulted from multisensory components of yoga. For example, he would consistently use his binder as a resource to replicate poses and select props from bin [Figure 4]. In addition, he would start the class with a vibrant imitation of vocal vowel sounds during chanting as they were combined with rhythmic gestures, and transition to a tranquil state under a towel, while laying down in ragdoll. Radhakrishna also noted a change in children throughout yoga to indicate their preference for Shavasana.[8]

**Figure 1:** Towel prop for proper alignment **Figure 2:** Super brain with partner
**Figure 3:**

## CONCLUSION

It appears that this multisensory enriched yoga did have a positive impact on this young boy's behaviors related to physical, social, and emotional well-being on and off the mat. Based on our positive findings, further research with a larger sample size and additional yoga sessions is warranted to investigate the long-term effects of multisensory yoga on behaviors that contribute to social and emotional well-being in school and community settings.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.


## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.


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**How to cite this article:** Scroggins ML, Litchke LG, Liu T. Effects of multisensory yoga on behavior in a male child with Apert and Asperger syndrome. Int J Yoga 2016;9:81-4.

**Psychother Psychosom 2016;85:53–55**
**DOI: 10.1159/000431257**

# Group Drumming Modulates Cytokine Response in Mental Health Services Users: A Preliminary Study

*Daisy Fancourt* [a, b], *Rosie Perkins* [a], *Sara Ascenso* [a], *Louise Atkins* [a], *Stephen Kilfeather* [c], *Livia Carvalho* [b], *Andrew Steptoe* [b], *Aaron Williamon* [a]
a Centre for Performance Science, Royal College of Music, and
b Psychobiology Group, University College, London , and
c Aeirtec Laboratories, Newcastle , UK

Received: March 2, 2015
Accepted after revision: May 6, 2015
Published online: November 27, 2015

Research over the past two decades has explored the role of immune processes in a range of mental health conditions and has shown that pro-inflammatory cytokines, which promote systemic inflammation, can act as neuromodulators, orchestrating immunological and behavioural changes associated with depression [1] . Patients with depression exhibit decreases in cytokine levels proportionate to their degree of recovery when treated either with pharmacotherapy, psychotherapy or a combination of both [2] . In recent years, a number of programmes have developed across the UK and internationally providing psychosocial interventions such as yoga and mindfulness to improve symptoms of mental health conditions and reduce inflammatory response [3, 4] . One promising psychosocial intervention is music, and a recent systematic review identified over 60 studies showing the immunemodulating effects of a range of music interventions [5] . However, to date, music interventions have not been researched as inflammatory- reducing therapeutic agents in mental health. Consequently, the current pilot study was designed to test the feasibility of using music interventions in mental health. The study explored the effects of group drumming on a broad array of inflammatory measures over a 6-week

intervention. Drumming was selected as the music intervention because of the inclusiveness of drumming circles and lack of fine motor skill requirements, and because strong steadying rhythms suggest that it may be particularly suitable in mental health settings. Furthermore, two previous short studies (single drumming sessions) involving healthy participants have found changes in biological response [6, 7] .
We hypothesised a decrease in depressive symptoms, pro-inflammatory activity and cortisol along with an increase in wellbeing across the entire 6-week intervention, and an increase in positive affect, decrease in cortisol and an increase in immune-enhancing activity evident immediately after a single session:

To test these hypotheses, in the week preceding and following the 6-week intervention, participants completed psychological scales including the Hospital and Anxiety Depression Scale (HADS), the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS), the Connor-Davidson Social Resilience Scale (CDRISC) and the Secker Scale for social inclusion. Immediately before and after the first and final sessions of the 6-week intervention, participants completed visual analogue mood scales, blood pressure measurements and provided a saliva sample, collected via passive drool method and stored immediately at –20 ° C. Recent research has documented the promise of salivary measurement in psychobiological research as a non-invasive, pain-free tool [8–10] . Saliva samples were analysed using Luminex multiplex assays. Thirty-one adults with affective disorders accessing mental health services took part in the study (8 men and 23 women; mean age ± SEM: 52.8 ± 2.45 years), recruited from hospitals, mental health professionals and support organisations and charities operating in North West London. As this was a preliminary study, participants were recruited with a range of mild and moderate mental health conditions. Exclusion criteria were severe anxiety or depression that prevented informed consent, a confounding comorbidity, or use of steroid or immunosuppressive medication. Participants took part in 70-min group drumming sessions in groups of 15–20 over a period of 6 weeks. Sessions consisted of call-and-response exercises and learning drumming patterns that built up into larger pieces.

We used repeated-measures ANOVAs to test changes in subjective reports and immune measures across individual sessions and the whole intervention. Corrections for multiple comparisons were made using Simes' test, and all p values presented are corrected.
We tested whether age and sex affected the observed differences in outcomes, but since they had n no effect we did not control for these variables in the final models.

Results are shown in table 1 . Across the entire intervention, significant improvements were found for depression, wellbeing and social resilience. From the beginning to the end of a single session, ratings of stress and tiredness levels significantly decreased and happiness, relaxation and energy levels increased (all $p < 0.002$, data not shown). Across the entire intervention, the concentrations of four cytokines were significantly lowered, demonstrating a reduction of pro-inflammatory response. There was no evidence of a decrease in cortisol. From the beginning to the end of session 1, the concentration of four cytokines significantly increased, and from the beginning to the end of session 6, seven cytokines significantly increased and cortisol decreased. To test this difference in response noted between week 1 and week 6, we compared change scores calculated by subtracting the scores before a drumming session from scores after the same drumming session. This was only carried

out for a subset of participants who had provided viable saliva samples above the level of detection at both time points in sessions 1 and 6. We found that four biomarkers had significantly stronger alterations across session 6 compared with session 1: interleukin (IL)-2 ($p = 0.013$), IL-6 ($p = 0.021$), interferon-γ (IFN-γ, $p < 0.001$) and cortisol ($p = 0.001$). It is possible that responses during the first session were confounded by the anxiety of being in an unusual location with new people doing an unfamiliar activity. Or alternatively, participants may have become more responsive to the intervention as the weeks progressed. Blood pressure was not reduced although there was a decrease in heart rate of 5.85 bpm ($p = 0.003$). Measures were taken immediately after sessions, and it is possible that greater effects would have emerged over a longer period. This study demonstrated for the first time that group drumming for mental health service users can lead to reductions in cortisol and immune enhancement over individual sessions as well as reduce inflammatory activity over a 6-week span. Changes in biomarkers are supported by changes in psychological profiles of participants, demonstrating the potential of group drumming as an intervention for mental health. This supports the undertaking of further controlled studies to test fully the therapeutic potential of group drumming interventions and other music-based psychosocial interventions for mental health patients.

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**Acknowledgments**

This research was carried out as part of 'Creative Practice as Mutual Recovery', a Connected Communities project funded by the UK's Arts and Humanities Research Council (grant ref. AH/K003364/1). The study protocol was approved by the UK NHS National Research Ethics Service under approval ref. 13/LO/1811 and registered under clinical trial number NCT01906892.

Aaron Williamon
Centre for Performance Science, Royal College of Music
Prince Consort Road
London SW7 2BS (UK)
E-Mail aaron.williamon @ rcm.ac.uk

# EMOTIONS

Universal emotions like anger, sadness and happiness are expressed nearly the same in both music and movement across cultures, according to new research.

The researchers found that when Dartmouth undergraduates and members of a remote Cambodian hill tribe were asked to use sliding bars to adjust traits such as the speed, pitch, or regularity of music, they used the same types of characteristics to express primal emotions. What's more, the same types of patterns were used to express the same emotions in animations of movement in both cultures.

"The kinds of dynamics you find in movement, you find also in music and they're used in the same way to provide the same kind of meaning," said study co-author Thalia Wheatley, a neuroscientist at Dartmouth University.

The findings suggest music's intense power may lie in the fact it is processed by ancient brain circuitry used to read emotion in our movement.

"The study suggests why music is so fundamental and engaging for us," said Jonathan Schooler, a professor of brain and psychological sciences at the University of California at Santa Barbara, who was not involved in the study. "It takes advantage of some very, very basic and, in some sense, primitive systems that understand how motion relates to emotion."

**Universal emotions**

Why people love music has been an enduring mystery. Scientists have found that animals like different music than humans and that brain regions stimulated by food, sex and love also light up when we listen to music. Musicians even read emotions better than nonmusicians.

Past studies showed that the same brain areas were activated when people read emotion in both music and movement. That made Wheatley wonder how the two were connected.

To find out, Wheatley and her colleagues asked 50 Dartmouth undergraduates to manipulate five slider bars to change characteristics of an animated bouncy ball to make it look happy, sad, angry, peaceful or scared.

"We just say 'Make Mr. Ball look angry or make Mr. Ball look happy,'" she told LiveScience. [See Videos of the Sad and Happy Bouncy Ball]

To create different emotions in "Mr. Ball," the students could use the slider bars to affect how often the ball bounced, how often it made big bounces, whether it went up or down more often and how smoothly it moved.

Another 50 students could use similar slider bars to adjust the pitch trajectory, tempo, consonance (repetition), musical jumps and jitteriness of music to capture those same emotions.

The students tended to put the slider bars in roughly the same positions whether they were creating angry music or angry moving balls.

To see if these trends held across cultures, Wheatley's team traveled to the remote highlands of Cambodia and asked about 85 members of the Kreung tribe to perform the same task. Kreung music sounds radically different from Western music, with gongs and an instrument called a mem that sounds a bit like an insect buzzing, Wheatley said. None of the tribes' people had any exposure to Western music or media, she added.

Interestingly, the Kreung tended to put the slider bars in roughly the same positions as Americans did to capture different emotions, and the position of the sliders was very similar for both music and emotions.

The findings suggest that music taps into the brain networks and regions that we use to understand emotion in people's movements. That may explain why music has such power to move us — it's activating deep-seated brain regions that are used to process emotion, Wheatley said.

"Emotion is the same thing no matter whether it's coming in through our eyes or ears," she said.

The study is detailed today (Dec. 17) in the journal Proceedings of the National Academy of Sciences.

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**FROM CARRIE**

# Meditaion & Relaxation

***"Our thoughts define our universe" –*** Piero Ferrucci

The cognitive approach sees feeling as a function of thought. How we view our world affects our feelings about it. We interpret, perceive, and make assumptions. In turn, our feelings and behavior are affected, feelings affect thought, thought affects feeling, creating an endless circle.

## The Relaxation Response

Titlebaum (1988) defines the three aims of relaxation as:

1. **A preventative measure** -- to protect body organs from unnecessary wear

2. **A treatment** -- to help alleviate stress in conditions such as hypertension, tension headache, immune deficiency… Relaxation techniques may help to make the body's innate healing mechanisms more available.

3. A coping skill -- to calm the mind and allow thinking to become more clear and effective.

**Body Systems associated with the states of stress and relaxation include:**

**1. The autonomic nervous system**

Sympathetic system increases arousal when the organism is under threat – fight or flight response. Negative emotional states, such as fear and anger are accompanied by the physiological changes associated with sympathetic activity:

- Increased heart rate
- Increased blood pressure
- Increased blood coagulation rate
- Heightened blood flow to voluntary muscles
- Raised glucose content of blood
- Increased respiratory rate
- Heightened acuity of the senses
- Increased sweat gland activity
- Decreased activity of the digestive tract
- Parasympathetic system restores the body to a resting state. It is important to note that not all-parasympathetic activity is benign.

- Asthma is exacerbated by bronchial constriction
- Gastric ulcers by acid secretion

**2. The endocrine system**

The endocrine system is closely associated with the autonomic nervous system, especially the adrenal gland activity, which produces glucocorticoids, including cortisol.

- The main function of cortisol is to maintain the fuel supply to the muscles
- High levels of cortisol, such as those produced by prolonged stress, are associated with a suppressed immune system.

**3. The skeletal musculature**

The release of tension in the skeletal musculature has the effect of calming the mind (Jacobson, 1938). This ability can be consciously cultivated.

**General Aspects of Relaxation Training**

- A quiet, warm setting free from disturbance.
- A feeling of safety, confidentiality.
- Body Positioning – for deep relaxation lying is preferred to sitting.
- Communicate a description of the method and the benefits of the process to be used.
- Calm frame of mind.
- Tone of voice for delivery that is quiet and calm.
- Termination – all procedures should be brought to a gradual end.
- Homework/ private practice.

## Methods for Exploration – from the West

1. Modified Jacobsen Progressive Relaxation – wrist bending backwards
2. Progressive Relaxation (Bernstein and Borkovec's approach)– making a fist
3. Passive Neuromuscular Relaxation
4. Kermani's Scanning Technique
5. Differential Relaxation
6. Stretching – supine twist
7. Breathing – deep abdominal
8. Bensonian Relaxation

## How to integrate MindBody into your existing Program

*Only as high as I reach I can grow,*
*Only as deep as I look I can see,*
*Only as far as I see I can go,*
*Only as much as I dream I can be....* Author Unknown

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# TOUCH

Processed by neurons in the brain. Mitra Hartman associate professor of biomedical and mechanical engineering in Northwestern University´s McCormick School of Engineering. Journal *eLife*

## Managing Overstimulation and Stress in Children with Autism

Children with autism can frequently become overwhelmed or over stimulated by situations beyond their control. As caregivers, teachers and therapists we may not always know the cause of their discomfort so its important to have a toolbox of calming strategies to help kids calm down, refocus and get back on task. Furthermore, you can prepare for a potentially stressful event by allowing a child to choose a calming activity and use it before the event and to calm down afterwards. Below is a list of common calming techniques you can use with the autistic children you support.

**Remember the rule of one.**

Use the rule of one when a child is deeply stressed, anxious or in the middle of a meltdown. Have only one person talk to the child with autism and ask them to do only one thing. Unfortunately most school models of crises call for bringing in lots of people, lots of people that start talking at once. Rather than calming a situation down this can escalate it. Remember to just have one person, ideally the person who has genuine affection for the child ask the child to do only one thing. This should be simple some examples could be sit in a chair, go to your calm place or take some deep breaths.

**Deep Breathing**

When a child becomes stressed or overwhelmed their heat rate increases and their breathing becomes fast and shallow. This creates high blood pressure. You can help a child stop this cycle by simply learning to take deep breaths. Deep breathing is a simple stress management tool that a child can use anywhere to calm and re-center themselves. Its important to teach and practice this technique often before stressful situations arise.

**Isometric Exercise**

Stop for a moment and squeeze your hands together then open them. As you let go of the tension in your muscles you should notice your muscles are more relaxed than before you started. Here are some simple isometric exercises:

- Making a fist and squeezing
- Pushing hands together
- Pushing knees together
- Shrug your shoulders
- Pushing against a wall
- Pulling against a rope tied around a pole in the playground

For a child who is having difficulty understanding the concept of isometric exercise give them a stress ball to squeeze. You can place the stress ball between their hands, knees, elbows or shoulder and neck to help them learn this relaxation technique.

**Deep Pressure**

Like isometric exercises, deep pressure also helps the muscles in the body to let go of tension. Here are a few common ways you can provide deep pressure to children with autism:

Weighted Puppy Wrap

- Weighted Items: blankets, vests or lap pads
- Bear hugs – preferably initiated by child
- Allow the child to wrap themselves up tightly in a blanket or sheet
- Play Doh, or Living Sand – include tools to increase muscle resistance so kids really use the muscles in their hands and fingers.

**Massage**

- Have child rub lotion on their arms and legs. Be cautious about smells, it may seem like a good idea to use "calming" lavender lotion but this may not be socially appropriate for boys. Some children are also very sensitive to smells.

- We have found a soft vibrating massage pillow allows a child to provide themselves with calming vibration. Pressure activated pillows also encourage some isometric exercise.
- Provide a small hand held massager the child can control.

**Provide a Box of Tactile Items**

Some children find very calming a box of interesting things to touch. This can include soft swatches of fabric, soft squishy toys, or small stuffed animals.

**Create a Calming Area**

Snug Rug

Provide a calming place with fidget toys, pillows, bean bag and a soft blanket. This can be as simple as a corner in a room or even a small area rug with calming items behind a teacher's desk. Make sure to practice going there so the child will identify it as a safe place.

**Communication**

Often stress happens when someone new is working with a child with autism. Remember to communicate across team members and especially with new members. This can be as simple as creating a short "cheat sheet." Along with therapy goals make a list of behaviors to watch for that indicates stress, successful calming techniques and contact information for the team leader or primary care giver in case a quick consultation is needed.

http://www.nationalautismresourcesblog.com/2013/11/04/managing-overstimulation-stress-children-autism/

# Efficacy of Sensory and Motor Interventions for Children with Autism


- Grace T. Baranek

1. 1.The Clinical Center for the Study of Development and LearningChapel Hill


Article



## Abstract


Idiosyncratic responses to sensory stimuli and unusual motor patterns have been reported clinically in young children with autism. The etiology of these behavioral features is the subject of much speculation. Myriad sensory- and motor-based interventions have evolved for use with children with autism to address such issues; however, much controversy exists about the efficacy of such therapies. This review paper summarizes the sensory and motor difficulties often manifested in autism, and evaluates the scientific basis of various sensory and motor interventions used with this population. Implications for education and further research are described.



Sensorimotor therapies evidence-based treatments sensory integration


## Preview

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# Sensory symptoms in children with autism spectrum disorder, other developmental disorders and typical development: A longitudinal study

Carolyn McCormick,[1] Susan Hepburn,[2] Gregory S Young,[3] and Sally J Rogers[3]
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The publisher's final edited version of this article is available at Autism

Go to:

## Abstract

Sensory symptoms are prevalent in autism spectrum disorder but little is known about the early developmental patterns of these symptoms. This study examined the development of sensory symptoms and the relationship between sensory symptoms and adaptive functioning during early childhood. Three groups of children were followed across three time points from 2 to 8 years of age: autism spectrum disorder, developmental delay, and typical development. At each time point, parents filled out questionnaires regarding their child's sensory symptoms and adaptive functioning. At the initial time point, parents of children with autism spectrum disorder reported more sensory symptoms in their children than parents in the typical development group. Parents in the autism spectrum disorder group reported more sensory symptoms than parents in the developmental delay group within smell, taste, and auditory domains. While the typical development group decreased in reported sensory symptoms across the study period, the clinical groups demonstrated no

significant change across assessment points. Sensory symptoms for all groups were not independently predictive of adaptive functioning when verbal mental age was also included in the model. The young age range at the initial assessment and pattern of results suggest that sensory symptoms are present early in the etiology of autism spectrum disorder and other developmental disorders and remain stable over time.

**Keywords:** adaptive behavior, autism spectrum disorder, longitudinal studies, sensory symptoms

Go to:

# Introduction

Sensory symptoms are a complex set of behavioral reactions to the sensory environment. Sensory symptoms can be broken down into three patterns: hyperresponsiveness, hyporesponsiveness, and sensory seeking (Miller et al., 2007). Hyperresponsiveness involves overreactions to the sensory environment (e.g. covering ears to the sound of someone singing). Hyporesponsive behaviors are under-reactions to the sensory environment (e.g. not turning to a loud sound). Examples of sensory seeking behaviors include prolonged visual inspection of toys or repetitive touching of objects.

Recent estimates of prevalence of sensory symptoms of people with autism spectrum disorder (ASD) range from 69% to 93% in children and adults (Baranek et al., 2006; Billstedt et al., 2007; Klintwall et al., 2011; Leekam et al., 2007) and were recently added as a diagnostic criterion of ASD in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-V; American Psychiatric Association, 2013). Despite the high prevalence rates of symptoms and their centrality to ASD, little is known about the developmental trajectory of these symptoms. The main purpose of this study was to characterize the early developmental pattern of sensory symptoms in ASD.

There has been debate about when sensory symptoms emerge (Baranek, 1999; Lord, 1995), as well as about their developmental trajectory (Baranek, 2002; Talay-Ongan and Wood, 2000). Lord (1995) suggested that sensory symptoms may not become clinically significant until the preschool years, but prospective studies of infant siblings at genetic risk of developing autism have found evidence of sensory symptoms present as early as social and communication symptoms (Ozonoff et al., 2010; Zwaigenbaum et al., 2005). From 2 years of age and beyond, there has been consistent documentation of significant sensory symptoms in children with autism when measured via parent report (Leekam et al., 2007; Rogers et al., 2003) and behavioral observations (Baranek et al., 2007; Leekam et al., 2007; Rogers et al., 2003).

Conflicting evidence exists about the relationship between sensory symptoms and chronological age. Some evidence suggests an increase in sensory symptoms over time (Ben-Sasson et al., 2009), compared to evidence that younger children have more sensory symptoms than older children (Leekam et al., 2007), and reports that symptoms are stable across childhood (Ausderau et al., 2014; Cheung and Siu, 2009; Green et al., 2012). Leekam et al. (2007) also found different relationships between sensory symptoms and age based on sensory domain.

There are several limitations with the extant research. First, very few studies have employed a longitudinal design. Most of the research on sensory symptoms uses cross-sectional groups of different ages or adds chronological age as a covariate to the primary analyses. The second difficulty is operationalizing sensory symptoms. Many studies use a total score or global measure that combines symptoms across response patterns and sensory domains. Other studies examine specific response patterns and/or specific sensory domains. Some researchers also combine sensory symptoms with other repetitive behaviors as part of the repetitive stereotyped behavior symptom set. Differences in how sensory symptoms are operationally defined may contribute to conflicting findings within the literature. Third, researchers often attempt to identify sensory behaviors from measures not designed to test these symptoms. For example, the autism diagnostic interview (ADI; Lord et al., 1994), while frequently used to measure sensory symptoms, combines sensory symptoms with repetitive behaviors, has a very restricted, skewed scoring range, and was not developed as a stand-alone measure of sensory symptoms.

Although sensory symptoms are not specific to ASD, as shown in studies that compare children with ASD to well-matched groups with other developmental delays (DDs; Leekam et al., 2007; Rogers et al., 2003; Wiggins et al., 2009), there may be certain patterns of response or sensory domains that are more prevalent in ASD than in other disorders. For example, Baranek et al. (2006) found that the under-responsive patterns of sensory behavior may be more prevalent in ASD. Differences found between groups may depend on whether they are matched on chronological or mental age (Kern et al., 2006). Differences in impairment between clinical groups may also be dependent on the classification of symptoms. The developmental pattern of sensory symptoms (i.e. when they emerge and whether they increase or decrease over time) may also be different in ASD compared to other populations, but has yet to be explored.

Unusual sensory behaviors have the potential to interfere with adaptive functioning, but the relationship between these constructs is currently unclear in ASD. Qualitative interviews with parents reveal that sensory symptoms limited participation in family routines and activities (Schaaf et al., 2011). Higher rates of sensory behaviors are also related to family and parent stress (Ben-Sasson et al., 2013). The relationship between sensory symptoms and adaptive functioning may depend on the age of participants, the domains of adaptive functioning and sensory processing being compared, and the inclusion of cognitive abilities as an additional covariate.

The aims of this study were threefold: (1) to describe the developmental trajectory of sensory symptoms in young children with ASD, (2) to test differences in the developmental trajectory of sensory symptoms among children with ASD, DD, and typical development (TD), and (3) to assess the effect of sensory symptoms on adaptive functioning over time.

# Methods

## Participants

Participants were seen as part of the National Institute of Child Health and Human Development/National Institute on Deafness and Other Communication Disorders

(NICHD/NIDCD) Collaborative Programs of Excellence in Autism (CPEA) network site at University of Colorado Health Sciences Center, Denver, CO. Participants in the clinical groups were recruited from various health and early education agencies, as well as parent support groups. Children with TD were recruited from the University of Denver subject pool.

The participant groups consisted of 79 children in three diagnostic groups: ASD (n = 29), DD of mixed/unknown etiology (n = 26), and TD children (n = 24). See Table 1 for participant characteristics. Participants in the two clinical groups were matched on chronological and mental age, and the group with TD was matched on mental age. As a result, the typically developing group was significantly younger than the other two samples ($p < 0.01$). Mental ages were measured with the Mullen Scales of Early Learning (MSEL: Mullen, 1995). There were no significant differences between groups at the initial time point on nonverbal mental age ($F(2, 82) = 0.05$, $p = 0.95$) or overall mental age ($F(2, 82) = 2.56$, $p = 0.08$). However, the groups were significantly different on verbal mental age (VMA) ($F(2, 82) = 8.79$, $p < 0.001$); the ASD group had significantly lower verbal scores than the DD group ($p < 0.05$) and the TD group ($p < 0.01$).

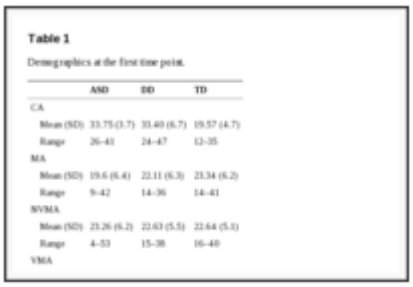

**Table 1**

Demographics at the first time point.

| | ASD | DD | TD |
|---|---|---|---|
| CA | | | |
| Mean (SD) | 33.75 (3.7) | 33.40 (6.7) | 19.57 (4.7) |
| Range | 26–41 | 24–47 | 12–35 |
| MA | | | |
| Mean (SD) | 19.6 (6.4) | 22.11 (6.3) | 23.34 (6.2) |
| Range | 9–42 | 14–36 | 14–41 |
| NVMA | | | |
| Mean (SD) | 23.26 (6.2) | 22.63 (5.5) | 22.64 (5.1) |
| Range | 4–53 | 15–38 | 16–40 |
| VMA | | | |

Table 1
Demographics at the first time point.

The children in the ASD group had to meet the following inclusion criteria: (1) previous clinical diagnosis of autism, (2) current clinical diagnosis from expert clinician, (3) full criteria for autism on the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; DSM-IV) checklist, and either (4) scores above the cut-off for autism on the ADI (Lord et al., 1994) or (5) scores above cut-off on the autism diagnostic observation schedule (ADOS; Lord et al., 1999). Most children met all five criteria. Participants in the DD group had an overall standard score on the MSEL between 35 and 70, no past or current diagnosis of ASD or fragile X syndrome, and did not meet criteria for ASD on two or more of the autism diagnostic measures (e.g. ADOS, ADI, DSM-IV). The children in the TD group had average scores or higher on developmental measures and did not meet criteria for ASD. Data from a portion of the current sample at age 2–3 years were previously published (Rogers et al., 2003).

## Procedures

This study was carried out under Institutional Review Board approval from the University of Colorado Health Sciences Center. Consent forms were reviewed with each family and all questions answered before consent was obtained and before any measures were gathered. Participants were seen at three time points. Ages of participants in each group are presented in the supplemental material (Table S1). The time interval between the first and

second waves of assessment had a mean of 21 months, whereas the second interval between waves 2 and 3 was longer with a mean of 51 months. The short sensory profile (SSP) was completed by the mothers before the laboratory visit at all three points. All other measures were collected in the laboratory over several visits that included additional measures not reported here.

## Measures

### Short Sensory Profile (SSP)

The SSP (McIntosh et al., 1999) is a sensory-specific parent report measure of abnormal behavioral reactions to the sensory environment frequently used in ASD research. It consists of 38 items from the longer sensory profile (Dunn, 1999), which was standardized on 1200 typically developing children. Items are scored for frequency on a scale of 0–4, with lower scores indicating more severe sensory abnormalities. In addition to a total score, there are also seven subscale scores: tactile sensitivity (e.g. withdrawal from water), taste/smell sensitivity (e.g. avoids certain tastes or food smells), movement sensitivity (e.g. distress when head is upside-down), under-responsive/seeks sensation (e.g. frequently touches people or objects), auditory filtering (e.g. distracted by a lot of noise), low energy/weak (e.g. poor endurance/tires easily), and visual/auditory sensitivity (e.g. covers ears to protect from sound). Parent report measures are especially useful to capture behaviors, like sensory symptoms, that can be infrequent or only occur in specific contexts that are difficult to recreate in the laboratory.

### Mullen Scales of Early Learning (MSEL)

The MSEL (Mullen, 1995) is a standardized developmental assessment for children ranging from 3 to 64 months of age. The MSEL was administered to all subjects according to standard instructions by raters with advanced degrees who were trained in assessing young children with autism and other DDs. Four subscale scores, visual reception, fine motor, receptive language, and expressive language, yield standard scores and age equivalence scores. These subscales were averaged to create separate verbal (receptive and expressive) and nonverbal (visual reception and fine motor) age equivalence scores. The verbal age equivalence score from the first assessment was used in the main analyses as a covariate.

### Vineland Adaptive Behavior Scales (VABS)

The VABS (Sparrow et al., 1984) is a standardized parent interview used to assess child adaptive functioning. The interview yields age equivalence and standard scores across four subdomains (communication, social, daily living skills, and motor skills) as well as an overall adaptive behavior composite (ABC). The interview was administered by a graduate student of psychology to the primary caregiver of the child during a laboratory visit.[1]

### Autism Diagnostic Observation Schedule (ADOS)

The ADOS (Lord et al., 1999) is a semi-structured standardized assessment using developmentally appropriate social and toy-based interactions in a 30- to 40-min session

that elicits symptoms of autism in four areas: social interaction, communication, play, and repetitive behavior. The ADOS was administered to all subjects in the study as part of the diagnostic qualification process. There are four different modules of the ADOS tailored to the developmental level of the child. In this study, Modules 1, 2, and 3 were used across the different time points. To account for differences in the modules, autism severity scores were calculated (Gotham et al., 2009). Autism severity scores range from 1 to 10 and are based on the total raw score from the administered module and the age of the child.

## Analytic plan

To answer the questions about developmental trajectory of sensory symptoms in ASD, multilevel models were fit with sensory symptoms as the dependent measure. All models were fit using the PROC MIXED procedure in SAS with the maximum-likelihood estimation method, to account for missing data due to participant drop out (Graham, 2009; Schafer and Graham, 2002). This procedure uses all available data to create estimates of effects, so all subjects are included regardless of missing values. The approach also allows flexibility in how time is treated within the model.

Models with the total score and seven subscale scores of the SSP as the dependent measures were run separately. Two models were tested for the total score and each sub-scale: no growth and linear slope. Two dummy coded variables were created to test differences between the three groups, one for the TD group and one for the DD group. The ASD group was the reference group. VMA at the initial assessment was also entered as a covariate. For the linear model, assessment time was measured as the number of months since the first assessment. This measure of time was used to account for differences in intervals between visits while still preserving chronological and mental age group comparisons. The random effect of time was also included in the linear model to test for variability in the slope. The addition of all main and interaction effects was tested for goodness of fit by a chi-square log-likelihood deviance test. Effects that did not significantly improve fit were not retained in the model.

To answer the question about the effect of sensory symptoms on adaptive behavior over time, multilevel models were fit using the SAS PROC MIXED procedure with maximum likelihood with the ABC from the VABS as the dependent measure. Group and VMA at the initial assessment point were entered as covariates, while the severity score from the ADOS and the SSP total score were time varying covariates. Two models were tested: no growth and linear slope. Time was treated in the same way as in the models described above. The addition of all main and interaction effects was tested for goodness of fit by a chi-square log-likelihood deviance test.

# Results - Data description

The number of participants with SSP data at each time point is reported in Table S1. Of the 79 participants, 91.1%, 69.6%, and 53.2% had SSP scores across the three assessment waves, respectively. Rates of retention did not differ across diagnostic groups. Correlations were run with the SSP at the initial time point to examine relationships between subscale scores (Table S2). Of 21 correlations, 10 reached statistical significance. All correlations between subscale scores on the SSP were small to moderate (absolute range: 0.03–0.48).

## Sensory symptoms

### Sensory symptoms between groups

Table 2 presents the parameter estimates of the best fitting models for the total score and all subscale scores. For the model of SSP total score, the ASD group was not significantly different than the DD group ($p = 0.94$), but the ASD group had significantly more sensory symptoms overall than the TD group ($p < 0.001$). At the initial time point, the TD group scored an average of 21.24 (confidence interval (CI) = 12.14–30.34) points higher than the ASD group across multiple symptoms. For the tactile sensitivity subscale, there was no difference between the ASD and DD groups ($p = 0.52$), but the ASD group had significantly more symptoms than the TD group ($p < 0.05$). The TD group scored an average of 3.61 (CI = 1.4–5.82) points higher than the ASD group. For the taste/smell sensitivity subscale, the ASD group had more symptoms than both the DD ($p < 0.01$) and TD ($p < 0.001$) groups. The DD group scored an average of 3.63 (CI = 1.69–5.57) points higher and the TD group scored an average of 6.02 points higher (CI = 4.00–8.04) than the ASD group. For the auditory filtering subscale, the ASD group had more symptoms than both the DD ($p < 0.01$) and TD ($p < 0.001$) groups. The DD group scored an average of 3.57 (CI = 1.34–5.80) points higher and the TD group scored an average of 5.57 (CI = 3.34–7.80) points higher than the ASD group. For the low energy/weak subscale, the ASD group had more symptoms than the TD group ($p < 0.001$) but fewer symptoms than the DD group ($p < 0.05$). The TD group scored an average of 5.66 (CI = 3.14–8.19) points higher and the DD group scored an average of 2.86 (CI = −5.33 to −0.39) points lower than the ASD group. Although the addition of group significantly improved model fit for the under-responsive/seeks sensation, movement sensitivity, and visual/auditory filtering subscales, the parameter estimates for the main effect of group did not reach significance.

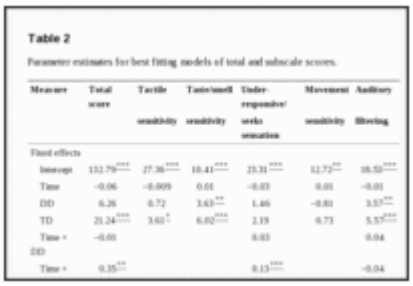

Table 2

Parameter estimates for best fitting models of total and subscale scores.

### Sensory symptoms across time and between groups

The overall main effect for time was significant ($\chi^2 = 23.5$, $p < 0.0001$). To answer the question of differences in the developmental trajectory of sensory symptoms across time between groups, models were also tested for interactions between slope and diagnostic group. For the SSP total score, children in the ASD and DD groups demonstrated no significant change, but parameter estimate of the interaction between time and the TD group reached significance ($p < 0.01$). The scores on the SSP for the TD group increased an average of 0.29 (CI = 0.05–0.53) points for each month enrolled in the study. The under-responsive/seeks sensation and visual/auditory filtering subscales demonstrated the same pattern of results. The ASD group demonstrated no significant change, the DD group was not significantly different from the ASD group, and the parameter estimates of the interaction between time and the TD group reached significance in both models ($p < 0.001$, $p < 0.01$, respectively). For the under-responsive/seeks sensation subscale, scores of the children in the TD group increased an average of 0.10 (CI = 0.04–0.16) points every month. For the visual/auditory filtering subscale, scores of the children in the TD group increased an average of 0.07 (CI = 0.01–0.13) points every month. For the auditory filtering subscale, although the interaction term significantly improved model fit, the parameter estimates for slope within all groups did not reach significance. In a model with the TD group as the reference group, the TD group demonstrated no significant change, but the parameter estimate of the interaction between time and the DD group reached significance ($p < 0.01$). For the auditory filtering subscale, the DD group decreased an average of 0.06 (CI = −0.11 to −0.01) points every month. Adding the interaction between diagnostic group and slope did not improve model fit for the tactile sensitivity, taste/smell sensitivity, movement sensitivity, or low energy/weak subscales. The parameter estimates of linear slope on these subscales did not reach significance. Across all models, there were significant estimates of variance in the intercept. Only the taste/smell sensitivity model had a significant random slope; however, the effect was small. This suggests variability between subjects in their scores, but not variability in how those scores changed over time.

## Sensory symptoms and adaptive behavior

For adaptive behavior, the best fitting model was the linear model with main effects of group, VMA, ADOS severity score, and SSP total score (see Table 3 for parameter estimates). The TD group scored an average of 41.09 (CI = 31.43–50.75) points higher than the ASD group, but the ASD and DD groups did not differ in their overall scores. VMA, ADOS, and SSP all improved model fit and had significant parameter estimates when no other variables were in the model; however, with all of the predictors in the model, only the parameter estimate of the main effect of VMA reached significance ($p = 0.00$). VMA scores were positively associated with VABS scores ($\beta = 0.65$; CI = 0.36–0.94). There were no significant interactions between slope and SSP or group and SSP. The variance terms for the intercept and slope were both significant; however, the slope estimate was small.

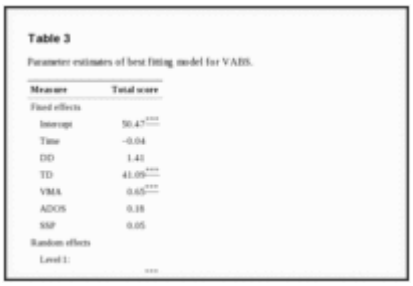

Table 3

Parameter estimates of best fitting model for VABS.

| Measure | Total score |
|---|---|
| Fixed effects | |
| Intercept | 50.47*** |
| Time | −0.04 |
| DD | 1.41 |
| TD | 41.05*** |
| VMA | 0.65*** |
| ADOS | 0.18 |
| SSP | 0.05 |
| Random effects | |
| Level 1: | |

[Table 3](#)

Parameter estimates of best fitting model for VABS.

[Go to:](#)

# Discussion

Abnormal sensory behaviors are frequent and often severe symptoms in children with ASD; however, little is known about the developmental course of these symptoms. The specific aims of this study were to identify the developmental trajectory of sensory symptoms in children with ASD, to examine differences in the development of sensory symptoms between diagnostic groups, and to examine the effect of sensory symptoms on adaptive functioning. When compared to children with TD, children with ASD demonstrated significantly more sensory behaviors overall and also on most subscales. However, children with autism did not have more sensory symptoms than children with other DDs overall and on most subscales. On two subscales: Smell/Taste Sensitivity and Auditory Filtering, children with ASD demonstrated more severe symptoms than children with other types of DD, replicating findings from other studies using the SSP to compare autism with other types of disabilities (Schoen et al., 2009; Wiggins et al., 2009).

On the SSP, elevated scores on the auditory filtering subscale may reflect social deficits as well as sensory features, given that items address response to name and other aspects of speech. Similarly, elevated scores on the taste and smell domain may reflect significant eating problems often found in ASD (Nadon et al., 2011), which can cause specific nutrient deficits and effects on lifelong health (Sharp et al., 2013). Response to items in this subdomain on the SSP should alert clinicians to assess nutritional status and also highlight the need for empirically based feeding interventions.

Our second question concerned developmental trajectories of sensory symptoms. Across the age ranges tested (i.e. 2–8 years), children with ASD demonstrated no significant change on either total SSP score or subscale scores, their sensory symptoms are elevated at a very young age and remain elevated throughout this period of childhood. The early emergence of sensory symptoms highlights the importance of having an interdisciplinary early intervention team that includes an occupational therapist. These results conflict with meta-analysis findings of worsening of symptoms across childhood (Ben-Sasson et al., 2009), and we cannot rule out the possibility that there may be changes in sensory symptoms at different developmental stages or when measured and analyzed in alternative methods. For example, one cross-sectional study that analyzed sensory symptoms by response pattern found a negative relationship between sensory seeking and age (Lidstone et al., 2014). This conflict may result from using the specific subscales of the SSP versus describing sensory symptoms by response patterns. Future studies should carefully consider the choice of

measurement tool in terms of how it categorizes sensory symptoms. The total score and the under-responsive/seeks sensation subscale models showed significant linear change across assessment points, driven by the group with TD, which had a reduction in sensory symptoms across assessments. The groups with ASD and DD demonstrated similar stable sensory symptoms across time as indicated by the nonsignificant variance in the estimate of slope.

Concerning effects of sensory symptoms on adaptive behavior functioning, our third question, we found no relationship between adaptive behavior and sensory symptoms either as a main effect or across time once we controlled for intellectual ability and other ASD symptoms. VMA was the only covariate with a significant positive effect on adaptive functioning. Children with higher VMA also had higher levels of adaptive functioning.

There were a number of strengths that support the validity of the present findings. First, sensory symptoms were quantified with the SSP, a psychometrically sound and a sensory-specific measure that provides scores for several domains of behavior. Second, a reasonably large group of children with ASD were compared to two other rigorously characterized diagnostic groups, with both mental and chronological age matches. Third, this study used a longitudinal design across three time points to answer questions about the development of sensory symptoms in autism. Fourth, the use of multilevel models fit with maximum likelihood is a well-established and recommended statistical procedure to account for missing data in longitudinal designs.

However, there were also some limitations. The sample size of this study, while large enough to examine group differences, was insufficient to investigate subgroups within the group with ASD. ASD is a complex disorder with varied presentations and there is some evidence for different subgroups of sensory symptoms within the autism spectrum (Lane et al., 2010). As with categorizations of restricted and repetitive behavior (Richler et al., 2010), there may be different developmental trajectories depending on the type of symptom or response pattern. Longitudinal studies will need larger samples to investigate individual differences or subgroups within ASD. Finally, a considerable portion of the sample was lost to follow-up. Although we were still able to include all participants within the analysis, attrition may have affected the estimation of model parameters.

Go to:

# Conclusion

This longitudinal study examined sensory symptoms in children with ASD across childhood. We found no significant evidence of change from 2 to 8 years of age in the frequency of parent-reported sensory symptoms in children with ASD. Children with ASD did not differ from children with other DDs in overall symptoms; both groups had more symptoms than children with TD. However, we replicated others' findings of more severe taste/smell sensitivity and auditory filtering symptoms in ASD than in other groups. Finally, the relationship between sensory symptoms and adaptive functioning appeared to be influenced more by language functioning than sensory impairment per se.

Go to:

This study was funded by the National Institutes of Child Health and Human Development PO1 HD35468, A Collaborative Program of Excellence in Autism.

## Footnotes

[1]The Vineland Adaptive Behavior Scales-II (Sparrow et al., 2004) was administered at the third time point.

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# Methods

## Methods and Materials

The aim of the study was to examine the effects of Drums Alive on motor performance and behavior of nursery-school children with developmental delays, in the area of motor performance, concentration and impulse control (n=16; 4.9-6.7 years).
The intervention was conducted twice a week for 45-60 min. over the duration of four weeks and was integrated in the daily routine. Different movement- and drumming patterns were combined to age appropriate music.
Baseline and Re-tests included the following measurements:
 Motor performance test of the Heinrich Heine University in Dusseldorf
 Weight, Height
 Documentation of behavior

A Drumming Exercise Intervention has significant effects on motor skill performance and behavior in children with intellectual disabilities and therefore seems to be a useful therapeutic tool in treating intellectual disabilities. Regarding the symptom specific and physiological effects of exercise therapy in patients with depression, improvements in both groups could be seen, but with no significant differences between a conventional exercise therapy and a Drumming Exercise Intervention. However, the last mentioned is able to arouse significantly more enthusiasm which in turn could lead to a better compliance regarding physical activity in general, but needs to be further investigated

DRUMS ALIVE ®. Children can be reached on an emotional level and develop high enjoyment of learning. Therefore the support of the children to be achieved could possibly be more effective than by other measures/interventions.

## Results

Motor performance in the intervention group improved significantly from 20.4 (SD 5.5) to 26.4 points (SD 5.3) which corresponds 33% ($p \leq 0.01$). Following the results are shown in a graph.
*Figure 2: results of the motor test*
The documentation of behavior (compliance with rules, better concentration and persistence, more creativity) showed individually better results in the intervention group compared to the control group.

**Conclusion**
All children of the intervention group showed partly significant improvements in different motor areas. The positive statements of the children and the results of the behavior monitoring show

the potential of Drums Alive as an additional therapeutic approach. The children have been caught emotionally and developed high pleasure in learning which makes DRUMS ALIVE potentially more effective than other interventions.
A final comparing evaluation with other exercise interventions based on this pilot study, is not possible, but the potential of an age specific DRUMS ALIVE Intervention should be further investigated.

## *2.1 Study 2*

### *2.1.1 Subjects*

The aim of this study was to examine the effects of a Drums Alive Kids Beats Intervention on the physical performance and behaviour of children with developmental delays in the areas of motor development, concentration and impulse control (aged 4.9-6.1 years) in comparison to children with a normal development (aged 4.1-6.1 years). All children were recruited from a pre-school in Bochum/Germany. Table 2 shows the descriptive characteristics of all subjects (Intervention group (IG); Control group (CG)). Written informed consent was received of the legal guardians of all subjects prior to their participation in the study.

- 16 Kindergarten children (Age 4,9-6,7 years), two children = Integrated Classroom,
  - Weaknesses in: Motor skill, concentration and impulsive behavior control.
- 10 children elementary school ages (4,9-6,7 years) with o. g. Handycaps
- 10 Kindergarten children (Ages 4,1-6,1 years) (Control group)

| **Institution** | **Age in years & n** | **Profile** |
|---|---|---|
| Nursery (IG) | 4.9-6.7<br>n = 6 | 2 children with SEN-Status<br>Deficiencies in the areas of motor skills, concentration and impulse control |
| Primary School (IG) | 4.9-6.7<br>n = 10 | With above mentioned handicaps |
| Nursery (CG) | 4.1-6.1<br>n = 10 | Control Group |

*Table 1: Descriptive characteristics of the subjects*

### *2.1.2 Behaviour and motor skills outcome measures*

The test profile (see table 3) consisted of the Duesseldorf Motoric Test (reference), which included 18 exercises, measurement of the anthropometric data as well as the documentation of different behaviour patterns. The latter has been documented during the intervention at each Drums Alive session. The motoric test as well as the anthropometric data has been conducted before and after the intervention phase.

| Test | Time |
|---|---|
| Duesseldorf Motoric Test – 18 exercises (Jump into a tire, balancing forwards, Tapping, grab a cloth with toes, jumping side-to-side, catch a stick, tennis balls in the box, balancing backwards, marker throwing, collect matches, winding through a tire, one-legged jump into a tire, catch a ring, jumping jacks, jumps over a rope, roll around the longitudinal axis, get up and sit down with ball, 2 turn jumps in a tire) | Pre & Post Intervention |
| Anthropometric data (height, weight) | Pre & Post Intervention |
| Documentation of Behaviour (motivation/fun, impulse control, coordination, concentration, implementation of tasks, creativity) | During Intervention |

*Table 3: Test profile*

### *2.2.3 Interventions*

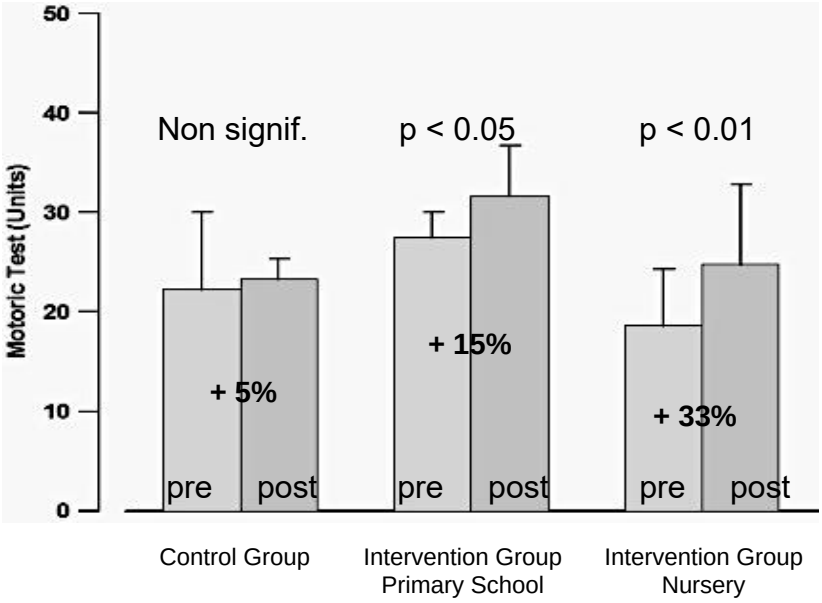
The subjects were allocated through the school teachers to either the intervention group (IG) or the control group (CG). The IG conducted two Drums Alive® sessions per week for 45 to 60 minutes each over a duration of four weeks. The sessions which have been incorporated into the daily school routine consisted of powerful dynamic movements combined with drumming on the stability ball as well as …

## 3.2 Study 2

### 3.2.1 Motor Skills

The following figure shows the results of the Duesseldorf Motoric Test shown in motoric units. Both intervention groups showed significant improvements in their overall motoric skills compared to the control group. With an increase of 33%, the children of the nursery intervention group benefited the most from the Drums Alive® intervention.

*Figure 2: Results of the Duesseldorf Motoric Tests*




### *3.2.2 Qualitative Results*

## Behaviour

### Examples of School Children

| Child | Reason for selection | Behavior before the intervention | Behavior after the intervention |
|---|---|---|---|
| A | Former (1x) Integrative child | Low self esteem, poor coordination level | Towards the end of the project improvements in coordination was noted. |
| B | Emotional disruptions | Low self-esteem, cognitive problems Poor Impulsive behavior contraol | Was able to apply and stick to the rules better, fostered creativity |
| C | AD(H)S Former (1x) Integrative child | Hyperactive, impulsive and lack of consistency, | Outbreaks were decreased and differentiated. Praise and approval created better consistancy |
| D | Very homogeneous, strong skills | Very homogeneously developed child, motor skills very strong | Developed pleasure,joy and creativity |
| E | Difficult Temperament | Crossed Boundries. Creative | Remained steady at constant rules was very creative |
| F | uncertainty | Lack of self-awareness, poor impulse control | towards the end of the project constancy and awareness improved as well as creative moments |

# Examples of kindergarten children (integrative)

| Child | Reason of selection | Behavior | Behavioral Chnges |
|---|---|---|---|
| G | Unilaterally deaf, visual weakness | Undisciplined, impulsive behavior, concentration weakness | Held partly to the rules and focused for about 30 minutes with constant praise and response |
| H | Triple-X-Syndrom | Did not handle new things well. Low self-esteem, balance problems | positively attuitide development. Was able to follow the rules better. Pounded at home with wooden spoons to boxes |
| I | Autistic traits, was behind in social and emotional development | Contact to others was limited.. Fine and gross motor skills regressed | Was able to present creatively to the group. Positive motor skills were development |
| J | Fear of losing someone (Sudden death of father) | Low self-confidence, coordination problems | Particpanted and remained with the group |
| K | Very prevelent and high level of Coordination problems | Low Self- Esteem, Coordination problems | Very committed. tried to get involved |

**Statements of the Children**

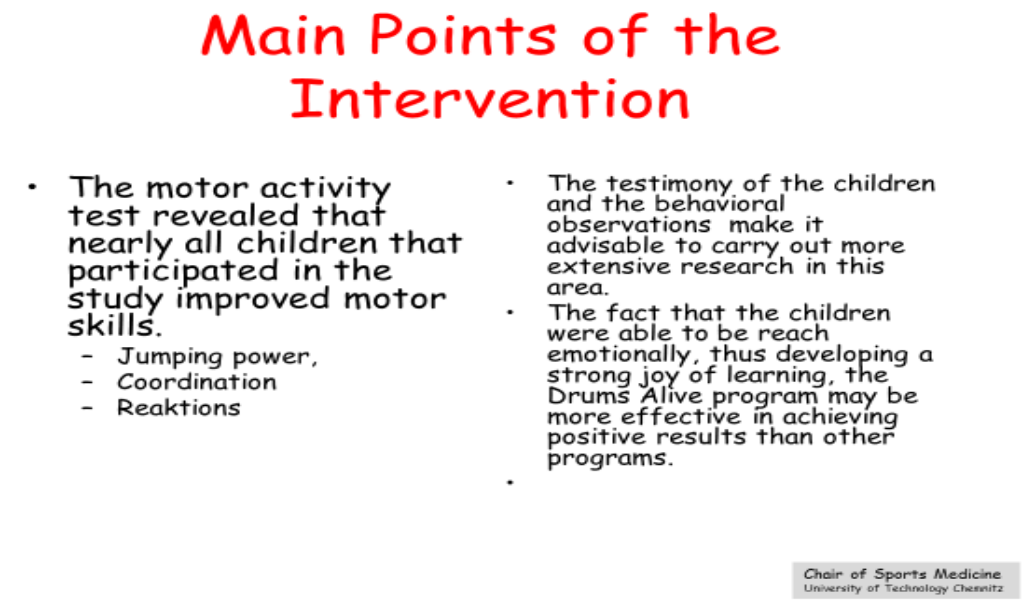
- The drumming is really great!
- How many times do we have to sleep before we get to drum again?
- Thank you for this beautiful drum time!
- I want to be a drummer!

**Statements of the Parents**

- Our child talks with enthusiasm about drumming
- Where can we buy a ball and sticks?
- My son had tears in his eyes when I told him that there is only one more drumming class.
- During the drumming project our home was more harmonious with less fighting and stress. – That´s really crazy!

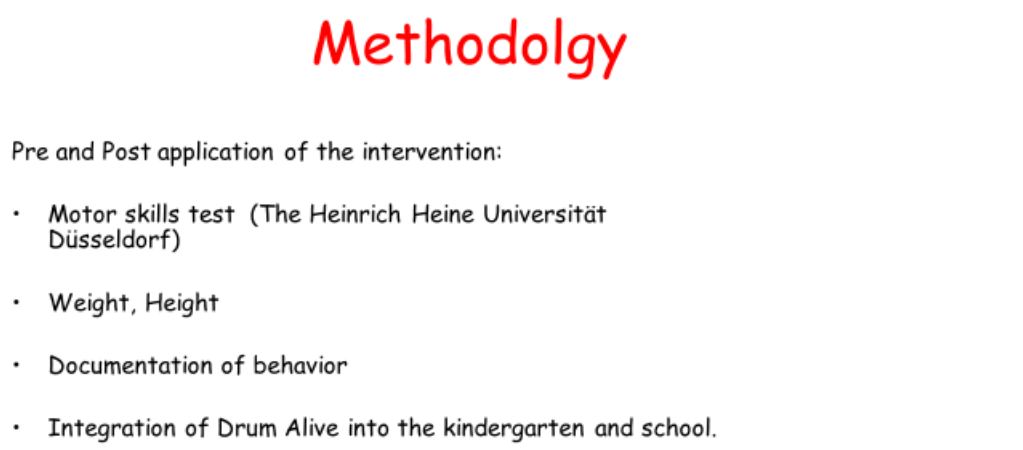
**Statements of the Teachers**

- Teacher: “For about three weeks your son has demonstrated better concentration in the English class, has something changed for your son or you?”
- Mother´s response: “He has been drumming for well over three weeks!”
- This teacher now wants to get educated in Drums Alive and begin drumming with her students!




**Instruments**

RPE – Rate of Perceived Exerction Chart




Aufgaben des Motoriktests - -Motor Test Skills

Balancieren vorwärts - Balance - Forward

Punktieren (Tapping) - Tapping ?)

Mit Zehen Tuch aufgreifen - Grip towells with toes

Seil seitlich überspringen - Jumping over Rope (sidwards)

Stab auffangen - Hanging on a bar

Tennisbälle in Kartons- Tennis Balls in Box

Balancieren rückwärts - Balance - Backwards

Zielwurf auf eine Scheibe - Throwing onto a disk
Streichhölzer einsammeln - Gathering matches
Durch einen Reifen winden - Going through a ring (hoop)
Einbeiniger Sprung in Reifen One leg hop in a ring (hoop)
Tennisring auffangen - Catching a Tennis Ring
Hampelmannsprung - Jumping Jacks
Sprung über Seil - Jumping over a rope
Rollen um die Längsachse - Log Roll
Aufstehen und Setzen mit Ball - Sitting and Standing on a Ball
Drehsprung in Reifen 2 x - Turning Jump 2x in a Hoop

# Data Analysis

Bla bla bla

# Results

Bla bla bla

# Discussion

A Drumming exercise intervention has shown significant effects on motor skill performance and behavior in children with intellectual disabilities. Supporting research in neuroscience, exercise therapy, music therapy as well as in the fields of mindfulness and stress reduction validate the importance of diverse, multi-modular programming and seems to be a useful therapeutic tool in treating intellectual disabilities.

# Conclusion

Conclusions: This study suggests that sportive drumming may have a measurable effect on motor skills and behaviour in children with developmental delays through treatment´s interactions with fundamental aspects of…. Including the ability to form and maintain relationships and prosodic abilities. Thus, sportive drumming may provide a basic and investigate the mechanisms of these interactions in greater depth.

*“Attempt to demonstrate that sportive drumming is a viable therapeutic form for developmentally delayed children, and in doing so elucidate what it is in sportive drumming that is valuable.*

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Die bisherigen Forschungsergebnisse zum Trommeln lassen darauf schließen, dass diese Form der Therapie auch bei Depressionspatienten wirksam ist. Einmal im Hinblick auf die positive Wirkung auf die Depressivität aber auch hinsichtlich der Verbesserung der körperlichen Leistungsfähigkeit.

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***Recognizing Developmental Delays in Children (C & D See the end of the paper for more information)***

As you watch your child grow, remember that each child develops at his or her own pace and the range of normal is quite wide. However, it is helpful to be aware of red flags for potential developmental delays in children. These delays are significant lags in one or more areas of emotional, mental, or physical growth. If your child experiences a delay, early treatment is the best way to help him or her make progress or even to catch up.

## Additional "What Are Developmental Delays in Young Children?"

There are many different types of developmental delays in infants and young children. They include problems with:

- language or speech
- vision
- movement -- motor skills
- social and emotional skills
- thinking -- cognitive skills

Sometimes, a delay occurs in many or all of these areas. When that happens, it is called "global developmental delay." Global developmental delay may occur for any of the following reasons:

- a genetic defect, such as Down syndrome
- fetal alcohol syndrome, caused by a mother drinking alcohol during pregnancy
- fragile X syndrome, an inherited type of cognitive impairment
- severe medical problems developing soon after birth, often associated with prematurity
- often no cause can be found

What follows are warning signs for different types of delays that may show up from infancy to age 2. You will also learn about some of the causes of developmental delays and potential treatments.

# Language and Speech Developmental Delays in Children

Speech delays in toddlers are common. In fact, language and speech problems are the most common type of developmental delay. Speech refers to verbal expression, including the way words are formed. Language is a broader system of expressing and receiving information, such as being able to understand gestures.

**Possible causes.** A variety of problems may cause language and speech delays, including:

- exposure to more than one language -- which can cause mild delays in toddlers but not delays by the time they reach school age
- a learning disability
- child abuse or neglect
- a problem with the muscles controlling speech -- a disorder called dysarthria

- hearing loss, which may occur in children who have severe middle ear infections or occur as a result of certain medications, trauma, or genetic disorders
- autism spectrum disorders -- a group of neurological disorders that may involve impaired communication as well as impaired social interaction and cognitive skills
- no cause can be found

**Types of treatment.** If you or your child's doctor suspects a speech delay problem, seek an evaluation by a speech-language pathologist. This specialist may test your child's hearing and use speech therapy with your child. The specialist or doctor may also suggest that you:

- communicate more with your child -- talk, sing, and encourage repetition
- read daily to your child
- reinforce speech and language throughout the day
- get treatment for middle ear infections

**Warning signs of speech or language delays.** Contact your child's doctor if your child has any of the following signs at the age that's indicated. In addition, watch for any loss of skills that have already been learned.

By 3 to 4 months, contact the doctor if your child:

- does not respond to loud noises
- does not babble
- begins babbling but does not try to imitate sounds (by 4 months)

By 7 months, contact the doctor if your child:

- does not respond to sounds

By 1 year, contact the doctor if your child:

- does not use any single words (like "mama")

By 2 years, contact the doctor if your child:

- cannot speak at least 15 words
- does not use two-word phrases without repetition; can only imitate speech
- does not use speech to communicate more than immediate needs

# Vision Developmental Delays in Children

Until 6 months, a newborn's vision is normally blurry. Then it improves as the child begins to coordinate sight in both eyes. However, sometimes this does not happen or other vision problems show up.

**Possible causes of vision delays.** Refractive errors, such as nearsightedness and farsightedness, are common in children. Other eye problems include:

- amblyopia (lazy eye), poor vision in one eye that may also appear to turn outward

- infantile cataracts -- a clouding of the eye's lens -- or another inherited problem (these problems are rare)
- retinopathy of prematurity, an eye disease that sometimes affects premature infants
- strabismus -- also called cross eyes -- eyes that turn in, out, up, or down

**Types of treatment for vision delays.** Early treatment can help correct many vision problems. Depending on the eye problem your child has, he or she may need:

- glasses or contact lenses
- special glasses
- surgery
- an eye patch

# Motor Skill Developmental Delays in Children

Developmental delays may be related to problems with gross motor skills, such as crawling or walking, or fine motor skills, such as using fingers to grasp a spoon.

**Possible causes of motor skill delays.** Children who are born prematurely may not develop muscles at the same rate as other children.

Other possible causes of motor delays include:

- ataxia, a defect that impairs muscle coordination
- cerebral palsy, a condition caused by brain damage before birth
- cognitive delays
- myopathy, a disease of the muscles
- problems with vision
- spina bifida, a genetic condition causing partial or total paralysis of the lower part of the body

**Types of treatment for motor skill delays.** Your child's doctor may suggest taking certain steps at home to encourage more physical activity. Your child may also need physical therapy for gross motor delays. Certain types of physical or occupational therapy may help with fine motor problems or sensory integration dysfunction.

**Warning signs of motor skill delays.** Contact your child's doctor if your child has any of the following signs at the age that's indicated. In addition, watch for any loss of skills that have already been learned.

By 3 to 4 months, contact the doctor if your child:

- does not reach for, grasp, or hold objects
- does not support his or her head well
- does not bring objects to his or her mouth (by 4 months)
- does not push down with legs when his or her feet are placed on a firm surface (by 4 months)

By 7 months, contact the doctor if your child:

- has stiff and tight or very floppy muscles
- flops his or her head when pulled into a sitting position
- reaches with one hand only or does not actively reach for objects
- has trouble getting objects to his or her mouth
- doesn't roll over in either direction (by 5 months)
- cannot sit up without help (by 6 months)
- does not bear weight on his or her legs when you pull him or her up to a standing position

By 1 year, contact the doctor if your child:

- does not crawl
- drags one side of his or her body while crawling
- cannot stand when supported

By 2 years, contact the doctor if your child:

- cannot walk (by 18 months)
- does not develop a heel-to-toe walking pattern or walks only on toes
- cannot push a wheeled toy

# Social and Emotional Developmental Delays in Children

Children may experience problems interacting with adults or other children, called social and/or emotional developmental delays. Usually these problems show up before a child begins school.

**Possible causes.** Some causes of social and emotional delays include:

- neglect from early institutionalization or parental neglect
- ineffective parenting or attachment problems
- cognitive delays
- an unknown cause

Another common cause of social and emotional developmental delays fall under the umbrella diagnosis autism spectrum disorder (ASD). This was previously referred to as pervasive developmental disorder (PDD), autism, aspergers and other names. ASD includes disorders that can cause a child have difficulty communicating, have repetitive behaviors and have language problems.

**Types of treatment.** There is no known cure for these conditions. However, treatment may include:

- special types of behavioral and skill-oriented therapy
- medication may help some problematic behaviors

As with most types of delays, early treatment can make a big difference in the progress your child makes. Depending upon the diagnosis, treatment may also include play therapy or steps to aid attachment between parent and child.

**Warning signs of social or emotional delays.** Contact your child's doctor if your child has any of the following signs at the age that's indicated. In addition, watch for any loss of skills that have already been learned.

By 3 months, contact the doctor if your child:

- does not smile at people
- does not pay attention to new faces, or seems frightened by them

By 7 months, contact the doctor if your child:

- refuses to cuddle
- shows no affection for parents or caregivers
- shows no enjoyment around people
- cannot be comforted at night (after 5 months)
- does not smile without prompting (by 5 months)
- does not laugh or squeal (by 6 months)
- shows no interest in games of peek-a-boo (by 8 months)

By 1 year, contact the doctor if your child:

- shows no back-and-forth sharing of sounds, smiles, or facial expressions (at 9 months)
- shows no back-and-forth gestures, such as waving, reaching, or pointing

# Cognitive Developmental Delays in Children

Problems with thinking, or cognitive delays, may be due to one or more of these reasons:

- genetic defects
- significant medical problems before birth
- exposure to something harmful in the environment, such as a toxin

**Possible causes.** Causes of cognitive delays include:

- a wide range of different learning disabilities
- exposure to alcohol or toxins before birth or afterward, including lead poisoning
- institutionalization or neglect during infancy or early childhood
- Down syndrome and other genetic disorders
- autism spectrum disorder
- severe newborn medical problems
- no known cause

**Types of treatment for cognitive delays.** As with most types of developmental delays, early treatment can make a big difference in the progress your child makes. Educational intervention can help your child develop specific cognitive skills. Educators and therapists may also recommend specific steps you can take at home to help your child.

**Warning signs of cognitive delays.** Contact your child's doctor if your child has any of the following signs at the age that's indicated. In addition, watch for any loss of skills that have already been learned.

By 1 year, contact the doctor if your child:

- does not search for objects that are hidden while he or she watches
- does not use gestures, such as waving
- does not point to objects or pictures

By 2 years, contact the doctor if your child:

- does not know the function of common objects, such as a hairbrush, telephone, or spoon
- does not follow simple instructions
- does not imitate actions or words

Remember: There is a wide range of normal development in children. Most developmental delays in children are not serious and children eventually catch up. Even children who do have serious delays can make big improvements when treatment begins as early as possible. If you have any doubts, talk to your child's health care provider.

https://www.webmd.com/parenting/baby/recognizing-developmental-delays-birth-age-2#1