

# Sensorimotor Processing and Central Coherence in Autism: Different occupations at the brain's paths

**Dr. Panagiotis Siaperas** *OT, CPsychol AFBPsS*

*Academic Link Person & Programme Leader BSc (Hons) Occupational Therapy  
Metropolitan College ,Athens ,Greece  
Research Associate University of Cambridge UK*

# Movement and Motor Abilities

- Movement and motor abilities are fundamental functions in the daily life of every person, not only because they affect everyone's functional performance but because they have other important roles in life.
- Movement in many cases is a form of non-verbal expression and social interaction between people. A good example of this non-verbal interaction and expression is dance



# Sensory Processing and Movement

- The Greek philosopher Aristotle was the first to describe between 384-322 BC the different senses and how every human organises perception through the various sensory systems.
- Aristotle described senses as attributes of soul and body in conjunction, which in turn affect the development of intelligence and safeguard the body.



# Asperger's syndrome / High Functioning Autism

It is a developmental disorder, which is included in the autism spectrum disorders and was described first in 1944 by Hans Asperger.



- Difficulties in social interaction.
- Difficulties in comprehension and use of communication, both verbal and non-verbal.
- Difficulties in imaginative activities, inflexible to changes, special interests.

## BUT

- They have typical language development.
- They have average intelligence.
- The symptoms are not so severe as in autism.

# Other issues

- Formal pedantic language
- Limited use of non-verbal communication (facial expressions & gestures).
- Suspicion for dyspraxia (clumsiness etc.)
- Resistance to change and pleasure only by repeated activities.
- Difficulties in interpreting social cues.
- Good memory skills.
- In some cases stereotyped movements.
- Special interests

# Piecing the puzzle together



**1<sup>st</sup> Asperger's  
Syndrome/ HFA**

**2<sup>nd</sup> Developmental  
Coordination  
Disorder / Dyspraxia**

**3<sup>rd</sup> Sensory Processing/  
Integration**



# 1<sup>st</sup> Asperger's (HFA) and Dyspraxia (1)

- Hans Asperger (1944): From the 46 children he examined, 91% had dyspraxia in catching a ball, poor handwriting and in balance on the right and the left leg.
- Manjiviona and Prior (1995), some children with Asperger's syndrome learn to walk a few months later than one would expect. In early childhood they may have limited ability in ball games & in learning to tie shoelaces.
- Research suggests that from 50% to 90% of children and adults with Asperger's syndrome have problems with motor coordination.

**BUT:**

- **Asperger's syndrome**
- Dyspraxia
- Sensory processing / integration
- Weak Central Coherence



# 1<sup>st</sup> Asperger's and Dyspraxia (2)

## BUT:

- The results of these studies are controversial and do not give us a clear outcome (Atwood, 1998).
- It is difficult and sometimes unclear to see how previous studies assessed developmental dyspraxia on people with Asperger's syndrome when none of them give an operational definition (Ghaziuddin, Tsai, & Ghaziuddin, 1992).





# 2<sup>nd</sup> Developmental Coordination Disorder

- There is much confusion on the terminology and definition of DCD or developmental dyspraxia.
- [ Siaperas, P. (2012). Motor abilities and developmental movement disorders: Problems in terminology. *World Federation of Occupational Therapists Bulletin*, 65, 28-34].
- *A. The acquisition and execution of coordinated motor skills is substantially below that expected given the individual's chronological age and opportunity for skill learning and use. Difficulties are manifested as clumsiness ( e.g. catching an object, using scissors, handwriting, riding a bike or participating in sports).*
- *B. The motor skills deficit significantly and persistently interferes with activities of daily living appropriate to chronological age (e.g. self-care) and impacts academic/school productivity , prevocational & vocational activities, leisure and play.*
- *C. Onset of symptoms is in the early developmental period.( DSM-V, 2013) .*



# Definitions based on Sensory Integration

- **Developmental Dyspraxia** is a brain dysfunction that hinders the organization of tactile and sometimes vestibular and proprioceptive sensations and interferes with the ability to motor plan. The word “developmental” indicates that the problem begins early in the child’s life and affects his/her development as he/she grows.” (Ayres 1972, 1979, 1989).
- **Somatodyspraxia:** “A disorder of encoding a new as opposed to habitual motor response strategy. That is people with somatodyspraxia have difficulty learning new tasks, but once learned and performed as a part of the person's daily life performance, the task can be performed with adequate skill” (Cermak, 1991).

# Sensory Perception

“Faulty”  
or poorly  
integrated  
sensory  
perception.

Accurate movement depends on accurate perception		
<b>Input</b> → ↑ ←	→ <b>Processing</b> → ← <b>Feedback</b>	<b>Output</b> ↓
<b>Sensory</b> → <b>Perception</b>	→ <b>Interpretation</b> →	→ <b>Movement</b> <b>Respon.</b>
<u>Senses:</u> <b>Kinaestheti</b> C → <b>Visual</b>	⇒ <b>Cerebral</b> <b>Cortex</b> →	<b>Efficient</b> <b>Movement</b> coordinated <i>balanced</i> <i>well-timed</i> <i>movement</i>



# 3<sup>rd</sup> Sensory Processing / Integration

Sensory Integration” refers to how brain manages input and produces output. Output includes motor responses. Children with motor difficulties often have problems in the integration of sensory input (e.g., visual, auditory, tactile, and proprioceptive cues); (*Jean Ayres*).

**Proprioceptive:** The sensation of where the body is in space and the positions of the various limbs and parts of the body.

**Vestibular:** The sensation to detect motion, especially acceleration and deceleration and the earth's gravitational pull.



Balance controls body both in movement and stillness. It depends on having accurate vestibular signals and in being able to make correct visual/spatial judgments, e.g. “How far am I from the wall?” “How quickly do I need to move?”



- Asperger's syndrome
- DCD/ Dyspraxia
- Sensory processing / integration**
- Weak Central Coherence

# Hypotheses/ Tests

1) Individuals with AS have impaired motor abilities compared with aged matched typically developing individuals.

Assessment: *Movement Assessment Battery 2 (Henderson & Sugden).*

2) Individuals with AS have a deficit in sensory processing (proprioceptive, vestibular) associated with movement performance.

Assessment: a) *Sensory Integration Praxis Test (SIPT), 1989*  
b) *Sensory Profile Test (Dunn, 1999).*

# Participants

50 children aged 7-14 years old diagnosed with AS are compared neurobehaviourally with a control group of typically developing children, matched on verbal IQ and socio-economic status, without any clinical diagnosis or learning difficulties.

# Results: Movement ABC-2 (i)

Lower total motor performance by children with AS [ $p < .01$ ]

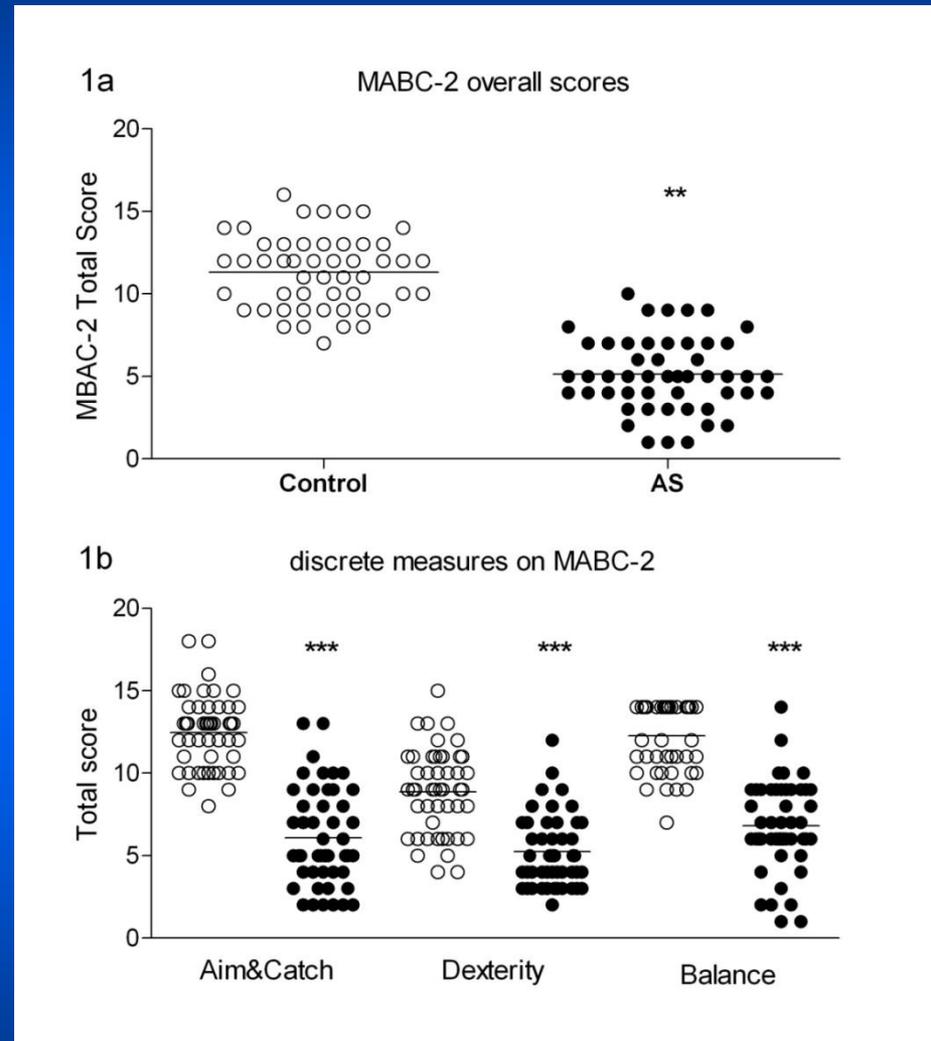
AS: ( $M = 5.1$ ,  $SD = 2.2$ ),

Control group: ( $M = 11.3$ ,  $SD = 2.2$ )

\*\*\*  $p < 0.001$

\*\*  $p < 0.01$

\*  $p < 0.05$

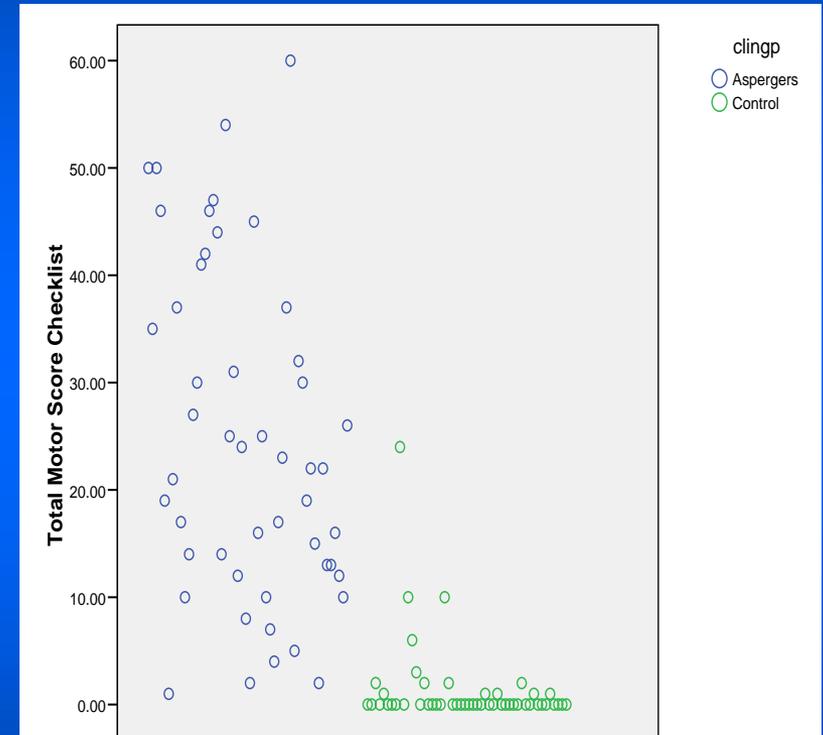


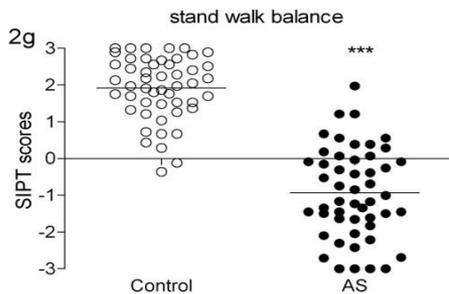
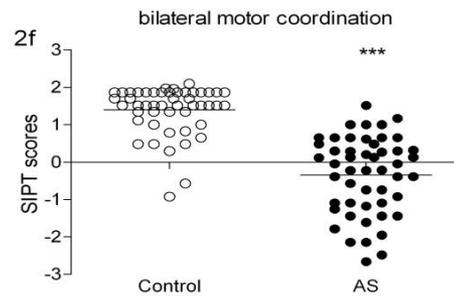
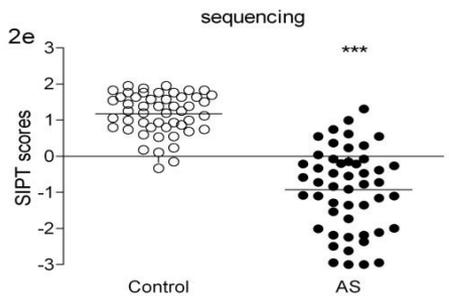
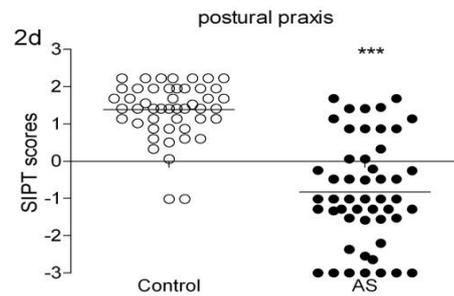
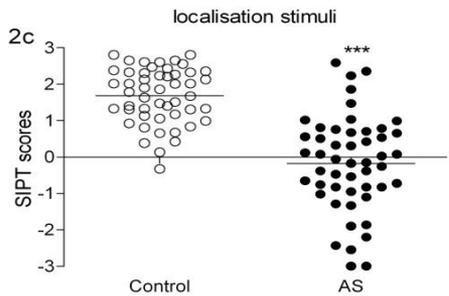
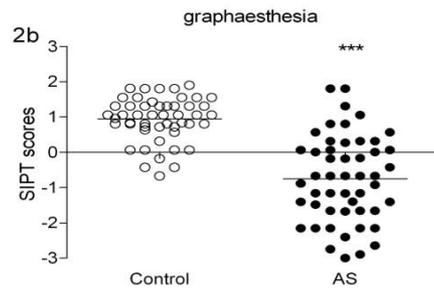
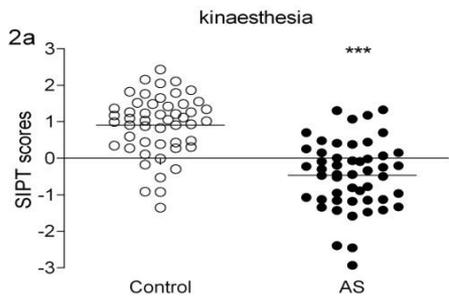
# Results: Movement ABC-2 (iii)

*Moreover in the Movement Assessment ABC Checklist:*

1. there was significant difference in parents' replies between control and Asperger's group.
2. children with AS have motor coordination problems.

[  $p < 0.01$  ]





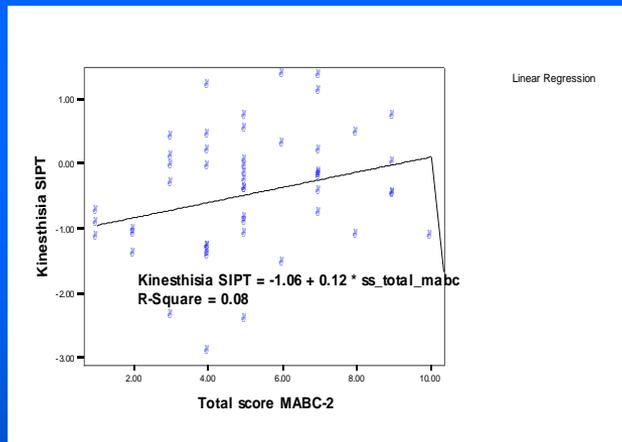
- Participants with autism demonstrated impaired performance in the Kinaesthesia and in the Standing Walking Balance sub-tests that require proprioceptive & vestibular processing.

\*\*\*  $p < 0.001$   
 \*\*  $p < 0.01$   
 \*  $p < 0.05$

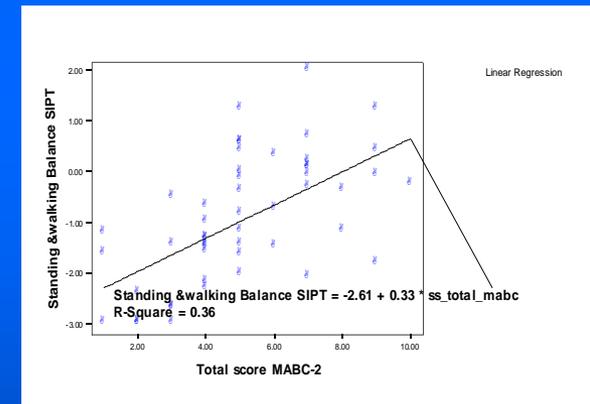


# Results: Correlation Sensory with Motor Tests of participants with AS

- Statistically significant associations between sensory tests of SIPT and the total motor score of MABC-2
- It seems that when we have low performance in motor tests it is more detectable low performance in the sensory tests like Kinesthesia and standing and walking balance. Generally the associations can be noticed easier in low performances.

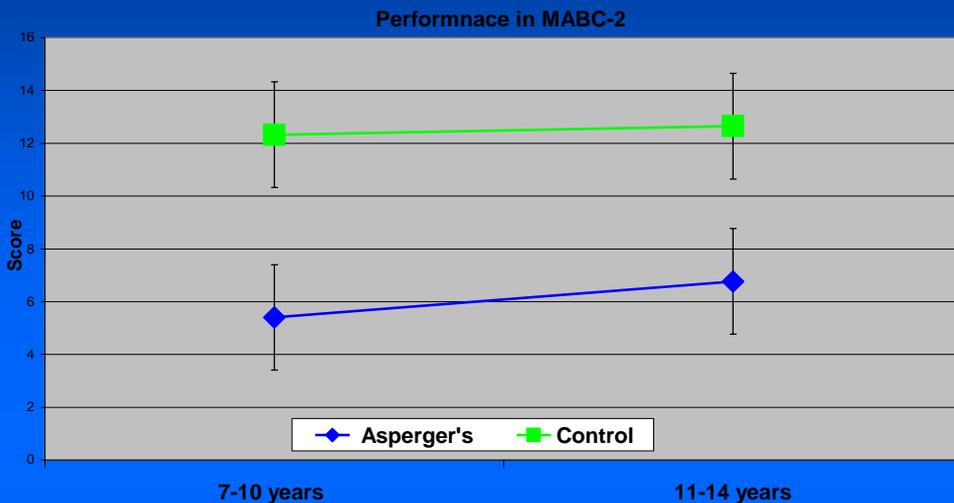


$$r = .280, N = 50, p < 0.05$$



$$r = .598, N = 50, p < 0.001$$

# Results: Developmental differences in Sensorimotor processing in AS



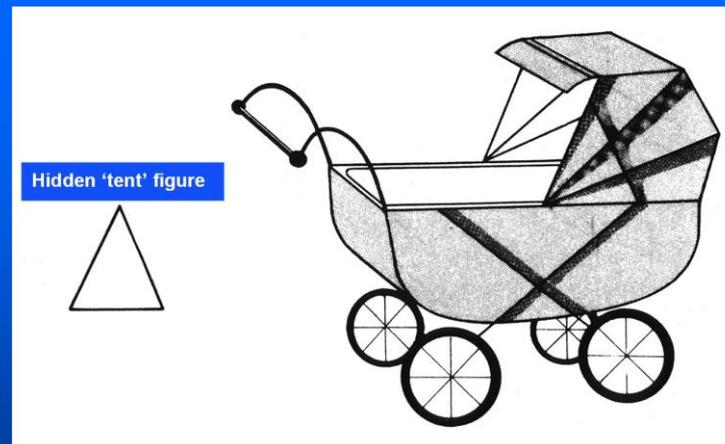
<i>M</i> ( <i>SD</i> )	AS	Control
<b>7-11</b>	4.72 (2.45)	10.68 (1.72)
<b>11-14</b>	5.52 (1.96)	11.96 (2.49)

Results from comparisons between the two age-groups in the SIPT were similar to those found in the MABC-2. Younger participants did not differ significantly from older participants.

However it is possible that any improvement in sensorimotor processing by the older age-group of participants with AS could not be demonstrated statistically because of the small samples

# Weak Central Coherence Theory

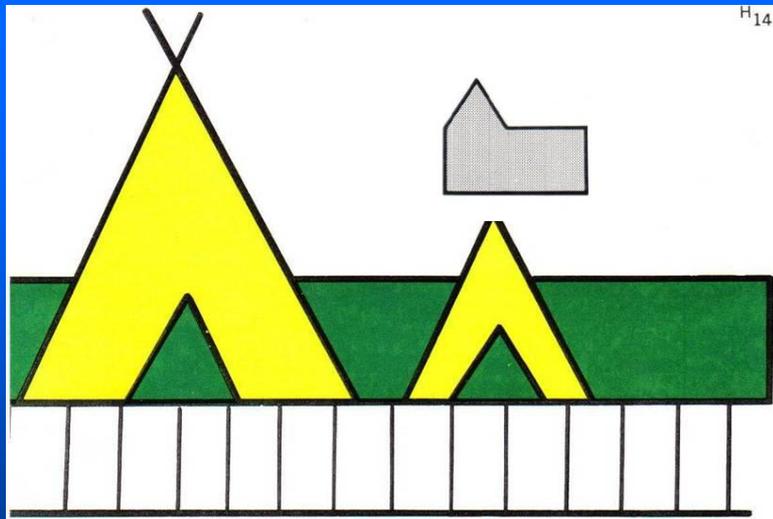
- The **weak central coherence theory (WCC)**, also called the **central coherence theory (CC)**, suggests that a specific perceptual-cognitive style, loosely described **as a limited ability to understand context or to "see the big picture"**, underlies the central disturbance in autism and related autism spectrum disorders (Frith, 1989).



# Central Coherence Tests

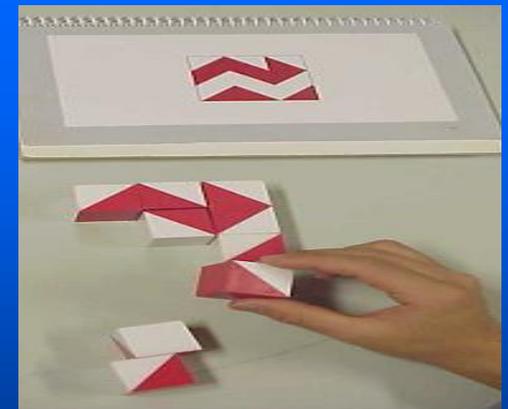
## 1) Children Embedded Figures Test

A small target shape has to be located in a drawing of a larger shape made up of confusing lines.



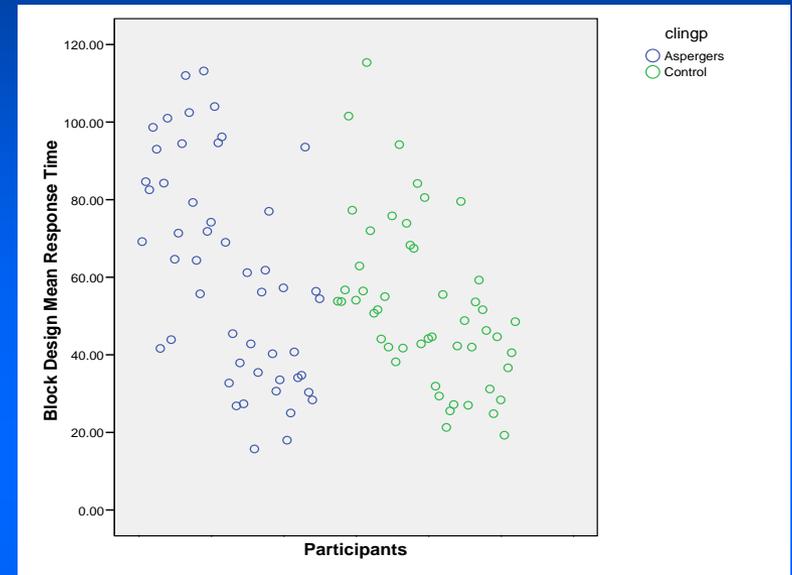
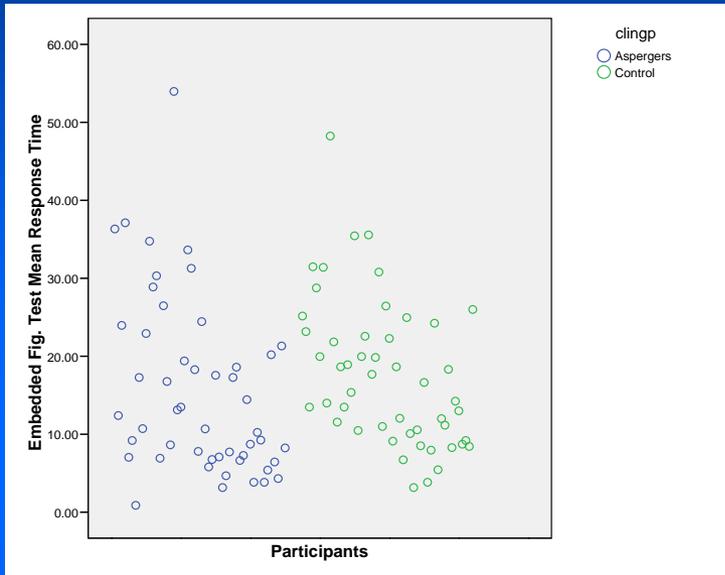
## 2) Block Design Test

The examinee uses blocks to replicate two-colour designs within specified time limit. There are 13 designs that progress from simple to more complex.



# Results: Central Coherence Tests

(Mean Response Time in the items of the test)



## Embedded Figures:

AS: ( $M = 15.50$ ,  $SD = 11.24$ )

Control: ( $M = 17.57$ ,  $SD = 9.41$ )

## Block Designs:

AS: ( $M = 61.27$ ,  $SD = 27.46$ )

Control: ( $M = 52.37$ ,  $SD = 21.0$ )

**Not Sig. difference between groups.**

## Results: Central Coherence Tests (Performances' observations)

- ❖ The six participants with AS (around the 10% of the group) who presented the poorest performance in the motor assessment presented the best performance in the embedded figures test (i.e. they were very fast in locating the hidden figure);
- ❖ It was also found that from the group of participants with AS three (around the 5%), who had the best motor performance had the poorest performance in the Children's Embedded Figures Test.
- ❖ The observation from the Block Design test is dissimilar with the Embedded Figures Test. Among those participants with AS 6 of them (10% of the AS group) who presented the poorest performance in the Manual Dexterity domain of MABC-2 were also among those presented the poorest performance in the Block Design test (i.e. they were the slowest in forming the designs with the blocks) and the opposite.
- ❖ Furthermore, both participants' groups presented statistically significant correlation between their performance on Kinesthesia task (which has impact to fine motor abilities) and Block design (which involves fine motor abilities) mean time response.

# Summary

- ❖ According to the data participants with AS have significantly impaired motor performance, providing support for the observation that people with AS have problems in motor coordination.
- ❖ The results show that participants with AS present impaired proprioceptive & vestibular processing, processes that according to the available literature affect motor behaviour such as balance, fine & gross motor skills.
- ❖ The outcome of the study showed that sensorimotor abilities remained impaired through the life course. Individuals with AS may improve with practise and training, but their level remained significantly lower than that of typically developing individuals.
- ❖ The outcome of the study did not reveal a statistically significant difference for individuals with AS in Children's Embedded Figures test and Block Design test. So the WCC theory was not statistically verified as was expected
- ❖ Associations between performance in the block design and movement performance.

# Clinical implications of the findings (i)

It is important to perceive sensorimotor impairments as yet another important aspect that affects the occupations of people with autism:

- ❖ Individuals in the autism spectrum because of sensory discomfort (mainly tactile) during their self care tasks (e.g. showering, tooth-brushing etc.), may neglect their personal hygiene, something that indirectly might affect their social competence.
- ❖ Impairments in proprioception and motor planning cause anxiety and confusion when they have to participate in novel or new activities. This anxiety could be an additional factor in the tendency for having routines or any behavioural problems.

# Clinical implications of the findings (ii)

Children diagnosed with DCD according to various studies:

- ❖ may be a risk factor for social academic and behavioural difficulties.
- ❖ may have lower academic achievements than typically developing children with poor hand writing being one of the biggest academic challenges.
- ❖ they are described by their parents as isolated, easily frustrated, introverted and socially immature.
- ❖ found to have limited participation in community sport teams or free play time with other children, compared to typically developing children. They avoid the playground and have less positive interaction with their classmates
- ❖ adolescents with DCD present lower self-esteem and greater anxiety.
- ❖ It was found, that for boys with the same age as those who participated in the current thesis, sports and appearance was the most important determinant of personal popularity, with academic achievement to be less important.

## Further information:

- Siaperas, P., Ring, H., Henderson, S., Barnett, A., Watson, P., & Holland, A.J. (2012). Atypical Movement Performance and Sensory Integration in Asperger's Syndrome. *Journal of Autism and Developmental Disorders*, 42, 718-725.
- Siaperas, P. (2012). Motor abilities and developmental movement disorders: Problems in terminology. *World Federation of Occupational Therapists Bulletin*, 65, 28-34.
- Siaperas P, Holland T, Ring H. (2007). Discriminative validity of the Movement ABC Test and Checklist for use with children with Asperger Syndrome In: S. Henderson D. Sugden A. Barnett (Eds.) *Movement Assessment Battery for Children -2 (Examiner's manual 157-159)*. London: Harcourt Assessment.

**Thank you !!!**



**[panagiotis.siaperas@gmail.com](mailto:panagiotis.siaperas@gmail.com)**