Social and Non-Social Dynamic Visual Attention among Autistic and Non-Autistic Children and Adolescents

Adina Gazith, Emily Stubbert, Hannah Marken, Olivia Furholter,
Jordyne Shatzky-Greenspoon, Armando Bertone, & Jacob A. Burack

McGill University, Montreal, QC, Canada

McGill Youth Study Team

Background

Performance on tasks of attention among autistic persons is often a function of developmental level rather than clinical diagnosis[1]

However, different biases to social versus non-social information have been noted on some attention tasks[7]

Accordingly, we administered dynamic three-dimensional (3D) versions of social and non-social tasks of attention that have been used before with autistic persons

Biological Motion (BM) task[3]
- Used to investigate visual attention to social information
  - Autistic persons display MA-appropriate abilities in:
    (a) detecting BM actions
    (b) differentiating between people and objects[4]

Multiple Object Tracking (MOT) task[5]
- Used to study visual attention to non-social information
  - Mixed findings on autistic participants' performance[6,7]

Methodological factors in interpreting the mixed evidence:

(1) Tasks often involve two-dimensional (2D) and motionless stimuli[2,8], although, in the real-world, attention typically directed to three-dimensional (3D) and dynamic stimuli[9]

(2) Attention to social information typically measured in isolation, without comparisons to how the same participants would attend to non-social tasks[10]

(3) When attention to social and non-social stimuli is assessed within the same study, tasks typically involve concurrent presentation of social *and* non-social stimuli[8]

In both BM and MOT tasks, the focus is on multiple stimuli, while additional distractor stimuli are ignored[11]

- Viewing these tasks in motion and in a 3D space taps into dynamic attention, which is necessary to focus on real-world and active stimuli

Aim of the Present Study

To assess autistic individuals' unique visual attention processing styles with tasks that are more ecologically relevant than traditional experimental tasks of visual attention.

Three research questions:

(1) Does performance on the BM and MOT tasks improve with age among both autistic and non-autistic children?

(2) Do autistic children perform better than or similar to non-autistic children on the BM and MOT tasks?

(3) Does children's performance on the social BM task relate to real world indicators of social functioning?

Method

Participants

- 27 autistic: 81.5% boys, 14.8% girls, 3.7% transgender
- 27 non-autistic: 51.9% boys, 48.1% girls

Variable	Autistic		Non-Autistic	
	Range	Mean(SD)	Range	Mean(SD)
CA	6-17 years	11.19(3.08)	6-17 years	8.81(2.35)
MA (PRI)	5-17 years	9.90(3.40)	4-16 years	9.53(3.33)
PRI Scores	--	87.23(15.40)	--	106.70(17.09)

Groups matched on WASI-II Perceptual Reasoning Index (PRI) Scores
- Satisfactory matching based on *t-test of* differences in PRI mental age using WASI-II ($t(52) = -.40, p = .690$)

Participants divided into two mental age (MA) groups:
- 4 to 10 years (lower) & 11 to 18 years (higher)

Standardized Measures

(1) Cognitive Status: Weschler Abbreviated Scale of Intelligence Second Ed. (WASI-II): Perceptual Reasoning IQ

(2) Attentional Ability: Conners' (Kiddie) Continuous Performance Test (KCPT-2; CPT-3):
- KCPT-2: 4-7 years (7 min); CPT-3: 8+ years (14 min)

(1) Social Competence : Multidimensional Social Competence Scale - Parent Report (MSCS-PR)
- E.g., 'Enjoys meeting new people'

Experimental Tasks

Three-Dimensional Biological Motion (3D-BM)Task

a. indicate whether the point-light walker moving in left or right direction

b. Number of noise dots increased after correct trial responses and decreased after incorrect trial response
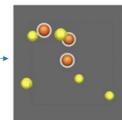
- 3D-BM Task DV: average number of distractor dots (noise) for which the participant could accurately detect the direction of the walker movement

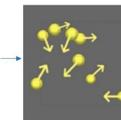Three-Dimensional Multiple Object Tracking (3D-MOT) Task
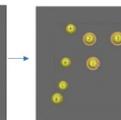
a. 8 identical spheres presented in 3D space
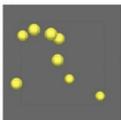
b. Three target spheres highlighted to identify which to track

c. de-identified spheres move randomly in space for 8 seconds

d. Spheres stopped and numbered; participants asked to identify target spheres

- 3D-MOT DV: top speed (in cm/second) at which participants could accurately track the three moving spheres

Results

(1) Visual Attention to Social Information : 3D-BM task

2x2 ANCOVA and bootstrapping analysis of BM performance between autistic and non-autistic groups grouped by lower MA and higher MA, controlling for CPT scores, was not significant, $F(4,47) = 1.08, p = .378, \eta p2 = .08$

- The autistic and non-autistic participants in both MA groups displayed similar BM performance, while controlling for CPT scores

(2) Visual Attention to Non-Social Information: 3D-MOT task

2x2 ANCOVA of MOT performance between autistic and non-autistic participants grouped by lower MA and higher MA, controlling for CPT scores was significant, $F(4,49) = 6.48, p < .001, \eta p2 = .346$

- Significant main effect of MA, $F(1, 49) = 15.88, p < .001, \eta p2 = .245$
  - Participants in higher MA group ($M = 1.09, SD = 0.42$) performed better than participants in lower MA group ($M = 0.64, SD = 0.37$)
- No main effect of autism group, $F(1, 49) = 1.28, p = .263, \eta p2 = .025$, nor interaction between MA and autism group, $F(1, 49) = 0.09, p = .765, \eta p2 = .002$
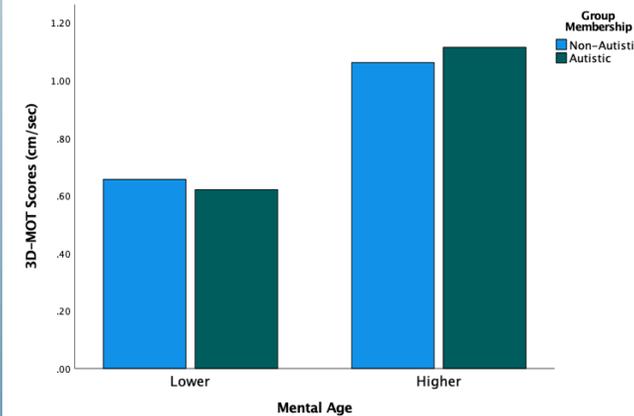
(3) 3D-BM and MSCS-PR

No significant correlation was found between 3D-BM task performance and overall MSCS-PR scores, r(46) = -.09, p = .56, for either autistic (r(22) = .07, p = .76) or non-autistic (r(22) = .37, p = .08) participants

Among non-autistic participants, correlations between 3D-BM task performance and MSCS-PR subdomain scores were significantly positively correlated for:
- Social knowledge subdomain (r(22) = .42, p = .04)
- Verbal conversation skills subdomain (r(22) = .52, p = .01)

Among the autistic participants, none of the MSCS-PR subdomain scores were related to 3D-BM task performance

Discussion

(1) 3D-BM task

No differences between autistic and non-autistic participants' performance

No differences found between lower and higher MA
- Ability to attend to BM develops early in infancy[13]

(2) 3D-MOT task

No differences found between autistic and non-autistic participants' performance

Higher MA participants performed better than lower MA participants
- Tracking multiple objects develops in adolescence[7]

(3) 3D-BM task and MSCS-PR

No overall association between BM and overall MSCS-PR scores
- Correlations between BM and MSCS subdomain scores (i.e., social knowledge; verbal conversation skills) found among non-autistic, but not autistic participants

Conclusions

The two primary findings indicate that:

(1) autistic and non-autistic participants performed similarly on the BM and MOT tasks

(2) participants in higher MA group performed better than those in lower MA group on the non-social MOT task.

These findings highlight that developmental level rather than clinical grouping may be a better predictor of real-world processing of information in the environment.

Acknowledgements
A special thanks to all the members of the Summit Center for Education, Research, and Training (SCERT), and specifically all the participating parents and children without whom this project would not be possible.

Selected References

1. Koldewyn, K., Weigelt, S., Kanwisher, N., & Jiang, Y. (2013). Multiple object tracking in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 43*(6), 1394-1405. https://doi.org/10.1007/s10803-012-1694-6
2. Brodeur, D. A., Stewart, J., Dawkins, T., & Burack, J. A. (2018). Utilitarian attention by children with autism spectrum disorder on a filtering task. *Journal of Autism and Developmental Disorders, 48*(12), 4019-4027. https://doi.org/10.1007/s10803-018-3619-5
3. Johansson, C. (1973). Visual perception of biological motion and a model for its analysis. *Perception & Psychophysics, 14*(2), 201-211. https://doi.org/10.3758/BF03212378
4. Parron, C., Da Fonseca, D., Santos, A., Moore, D., Monfardini, E., & Deruelle, C. (2008). Recognition of biological motion in children with autism spectrum disorders. Autism, 12(3), 261-274. https://doi.org/10.1177/1362361307089520
5. Pylyshyn, Z. W., & Storm, R. W. (1988). Tracking multiple independent targets: Evidence for a parallel tracking mechanism. *Spatial Vision, 3*(3), 179-197. https://doi.org/10.1163/156856888X00122
6. Evers, K., de-Wit, L., Van der Hallen, R., Haesen, B., Steyaert, J., Noens, I., & Wagemans, J. (2014). Brief report: Reduced grouping interference in children with ASD: Evidence from a multiple object tracking task. *Journal of Autism and Developmental Disorders, 44*(7), 1779-1787. https://doi.org/10.1007/s10803-013-2031-4
7. Van der Hallen, R., Evers, K., de-Wit, L., Steyaert, J., Noens, I., & Wagemans, J. (2018). Multiple Object Tracking reveals object-based grouping interference in children with ASD. *Journal of Autism and Developmental Disorders, 48*(4), 1341-1349. https://doi.org/10.1007/s10803-017-3383-y
8. Vacas, J., Antolí, A., Sánchez-Raya, A., Pérez-Dueñas, C., & Cuadrado, F. (2021). Visual preference for social vs. non-social images in young children with autism spectrum disorders. An eye tracking study. *PLOS ONE, 16*(6), e0252795. https://doi.org/10.1371/journal.pone.0252795
9. Birmingham, E., Ristic, J., & Kingstone, A. (2012). Investigating social attention: A case for increasing stimulus complexity in the laboratory. In J.A. Burack, J.T. Enns, & N.A. Fox (Eds.), *Cognitive neuroscience, development, and psychopathology: Typical and atypical developmental trajectories of attention* (pp. 251-276). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195315455.003.0010
10. Ristic, J., Mottron, L., Friesen, C. K., Iarocci, G., Burack, J. A., & Kingstone, A. (2005). Eyes are special but not for everyone: The case of autism. *Cognitive Brain Research, 24*(3), 715-718. https://doi.org/10.1016/j.cogbrainres.2005.02.007
11. Brodeur, D. A., Trick, L. M., Flores, H., Marr, C., & Burack, J. A. (2013). Multiple-object tracking among individuals with Down syndrome and typically developing children. *Development and Psychopathology, 25*(2), 545-553. https://doi.org/10.1017/S095457941200123X
12. Federici, A., Parma, V., Vicovaro, M., Radassao, L., Casartelli, L., & Ronconi, L. (2020). Anomalous perception of biological motion in autism: A Conceptual Review and Meta- Analysis. *Scientific Reports, 10*(1), 4576. https://doi.org/10.1038/s41598-020-61252-3
13. Burack, J. A., & Brodeur, D. (2021). Utilitarian attention. In F. R. Volkmar (Ed.), *Encyclopedia of Autism Spectrum Disorders* (pp. 4986-4992). Springer International Publishing. https://doi.org/10.1007/978-3-319-91280-6_102313

Fonds de recherche
Société et culture
Québec

SSHRC · CRSH
Social Sciences and Humanities Research Council
Conseil de recherches en sciences humaines