

Katy Coleman (2022)

Essay for Neurodevelopmental Disorders Module at Oxford Brookes University

Module Leader: John Lawson

WORD COUNT (not including essay question title, references, or table content): 2,529

TITLE

CRITICAL ANALYSIS OF WHETHER THE E-S MODEL SUCCESSFULLY CAPTURES THE DSM-V AUTISM SPECTRUM DISORDER DIAGNOSTIC CRITERIA AND INSIGHT PROVIDED FOR INTERVENTIONS

BACKGROUND

Autism was first identified by Kanner (1943) studying a small group of seriously linguistically and cognitively impaired children (Frith & Mira, 1992) showing an extreme need for aloneness and sameness from the outset of life, manifested by obsessive connection with physical objects, repetitive acts, social anxiety, and distancing from others (classic autism). Asperger (1944) identified a higher functioning group of children with similar symptoms but less severe learning difficulties, namely Asperger's syndrome (AS). Wing (1981) brought AS to public attention (Frith & Miru, 1992) advocating for classic autism and AS to be regarded as related by the triad of deficits (social interaction, social communication, and repetitive, restrictive behaviour) tending to cluster together in child development, requiring similar structured intervention. The triad formed the basis of pervasive developmental disorders in the DSM-IV including AS and classic autism in several related but distinct conditions (Hulme & Snowling, 2009). The DSM-V replaced these with a single diagnosis of autism spectrum disorder (ASD) ranging in severity (low, medium, high functioning autism; LFA, MFA, HFA respectively) and merged social interaction and communication into one domain, reflecting their inextricable link (Marshall, 2013), replacing the triad with a dyad (Hulme & Snowling, 2019; Black & Grant, 2014). The childhood ASD prevalence rate is 1% (Baird et al., 2006)

and the male to female ratio (MTRF) 3:1 (Loomes, Hull & Mandy, 2017), increasing to 6:1 in HFA (Hulme & Snowling, 2009).

MAIN COGNITIVE MODELS

Three main cognitive theories have guided ASD research in pursuit of a basic cognitive deficit (Rajendran & Mitchell, 2007): executive dysfunction (ED; Ozonoff, Pennington & Rogers, 1991), weak central coherence (WCC; Frith, 1989) and theory of mind (ToM; Baron-Cohen, 1990). Executive function (EF) captures the four phases (representation, planning, execution, and evaluation) of problem solving (Zelazo, Carter, Reznick & Frye, 1997) and ED theory proposes EF deficits characterise ASD (Ozonoff et al., 1991) but is nonspecific to ASD (Hulme & Snowling, 2009) and ignores the depth of processing required within obsessional interests (Baron-Cohen, 2008). WCC theory captures this characteristic: proposing abnormal strength in local processing and weakness in global processing (Frith & Happe, 1994). Pellicano, Maybery, Durkin and Maley (2006) dispute abnormal information processing as the sole explanation to symptoms because most social features are unaccounted for and better explained by ToM (Lawson, 2003). ToM is the ability to 'mentalize': represent the mental states of self and others to explain and predict behaviour (Premack & Woodruff, 1978; Frith & Happe, 1994). ASD is characterized by 'mindblindness' (Baron-Cohen, 2008): lacking mentalizing ability (Frith & Happe, 1994).

EMPATHIZING-SYSTEMIZING (E-S) MODEL

The E-S model is a dual-factor theory superior to single-factor theories (ED, WCC, ToM) focussing on either social or physical abnormalities of ASD (Morsanyi & Byrne, 2019). Encompassing and going beyond ToM: empathizing seeks to understand and predict behaviour in the social world (an ASD weakness), involving cognitive empathy (CE), described in ToM, to understand what others are thinking, and affective empathy (AE) to understand what others are feeling and have an appropriate emotional reaction, such as

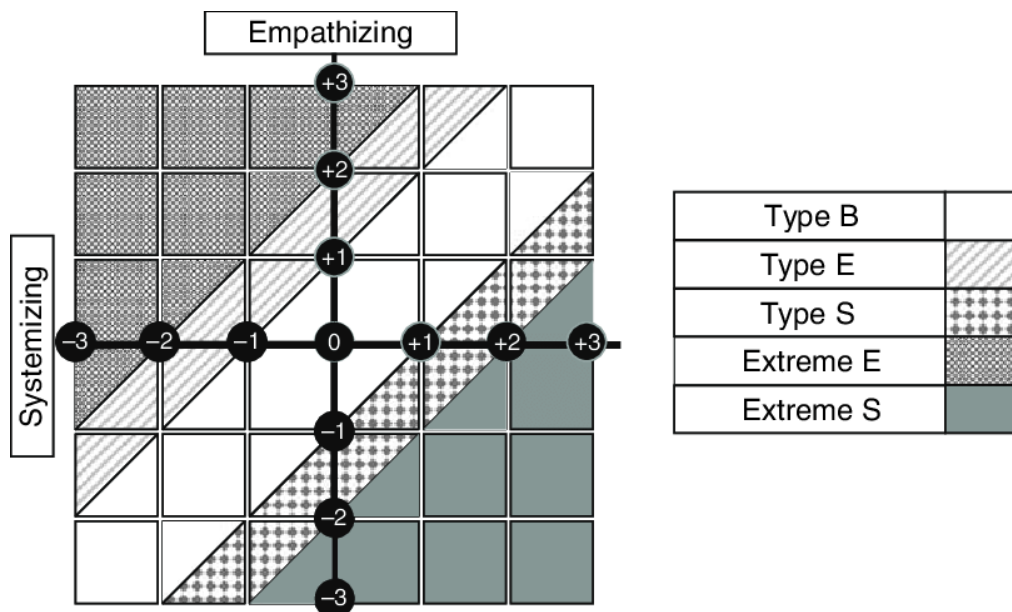
sympathy (Baron-Cohen, Wheelwright, Lawson, Griffin & Hill, 2002). Systemizing seeks to understand the underlying rules and predict behaviour in the physical world (an ASD strength), involving analysing and building the many systems which define the physical world such as technical (e.g. computer hardware), natural (e.g. glacier formation), and abstract (e.g. Pythagoras theorem) (Baron-Cohen et al, 2002).

The E-S model predicts five brain types (see figure 1; Baron-Cohen, 2002). Based on population averages, females have an empathizing bias toward type E and males a systemizing bias toward type S. ASD, male or female, always overlaps type S to extreme type S (excellent systemizing, grossly impaired empathizing) (Baron-Cohen et al., 2002), in this way, ASD is an extreme version of the male brain (Lawson, Baron-Cohen & Wheelwright, 2004) also conceptualized as hyper-systemizing: Baron-Cohen (2006a) proposed individuals possess an innate cognitive systemizing mechanism (SM) set at a certain level, females tend to be level 2, males level 3, talented systemizers level 4, AS level 5 and HFA, MFA and LFA; levels 6, 7 and 8 respectively. Hyper-systemizing theory thus captures the severity levels of the DSM-V, levels 5 + 6 requiring some support, level 7 substantial support, and level 8 very substantial support to increase functioning in daily life (Baron-Cohen, 2006a; APA, 2013).

Figure 1.

The Empathizing-Systemizing Model: (Baron-Cohen, 2002)

Axes show standard deviations from the mean



Broadly speaking, empathizing captures the social and communication difficulties in criterion A of the DSM-V, whilst restricted and repetitive behaviour (criterion B) is captured by systemizing (APA, 2013; Baron-Cohen et al., 2002). The DSM-V adds two specifiers (with or without intellectual disability (ID) and language delay) to the diagnostic criteria (APA, 2013). The presence of language delay and/or ID increases symptom severity (Matson & Goldin, 2013; Bos & Stokes, 2019), suggesting the E-S model only partially captures this aspect.

INTELLECTUAL DISABILITY + CRITERION E

Criterion E requires clinical assurance symptoms are not attributed to ID prior to diagnosing ASD (APA, 2013) due to considerable genotypic and phenotypic overlap (Thum, Farmer, Salzman, Lord & Bishop, 2019). HFA to LFA is characterised by higher to lower IQ respectively (Hulme & Snowling, 2009; Baron-Cohen, 2008) whilst ID is defined by low IQ in the context of adaptive functioning deficits (Schaepper, Hauser & Kagadker, 2021). An IQ test requires generalizing ability and dealing with some systems less than 100% lawful which high-systemizers may struggle with (Black, Wallace, Sokoloff & Kenworthy, 2009; Baron-Cohen, 2006b) but this doesn't fully capture low IQ. Both ASD and ID contain impairments in social function, but basic communication skills are ASD specific (e.g., eye contact/reciprocal

communication), and ID often includes motor and sensory impairments (Thum et al., 2019), not captured by E-S theory (Baron-Cohen, 2008).

LANGUAGE DELAY

Debate surrounds whether language delay is a specific language impairment comorbid with, or a phenomimcry of, ASD (Marshall, 2013). Baron-Cohen (2006b) proposed language is not 100% lawful, requiring social interaction/communication to learn, therefore systemizing-bias plus empathizing-deficits cause language delay. However, Wodka, Mathy and Kalb (2013) found repetitive (systematic) behaviours did not, but lack of social interest/engagement did, predict language delay suggesting partial capture by E-S theory.

CRITERION A

According to Baron-Cohen (2006a) The social world is unpredictable, changeable and unsystemizable: SM level 8 causes intolerance to change, a drive to systemize everything and withdrawal from people into the predictable world of things via the severest level of criterion A elements: failure to begin or respond to social interactions, complete lack of facial expression and nonverbal communication and total absence of interest in friends (APA, 2013; Baron-Cohen, 2006a). As the SM level lowers the person systemizes less of the time (Baron-Cohen, 2006b), increasing amounts of change are tolerated, leading to better social integration in a world where sociability is expected (Van der Zee & Derksen, 2021), requiring less support (APA; 2013).

Most with ASD have gross delay in second order false-belief tests (correct inference someone else wrongly thinks that someone else wrongly thinks; Leslie & Frith, 1988), explaining how mindblindness causes peculiar social approach and lack of reciprocity in play/conversation (criteria A; APA, 2013; Baron-Cohen, 2008), but without explaining this behaviour in those who passed these tests (Frith & Happe, 1994). Similarly, in the largest test of E-S theory to date, half a million people completed the EQ (empathizing quotient) and

SQ (systemizing quotient) (Greenberg, Warrier, Allison & Baron-Cohen, 2018). As table 1 shows, the notions of EMB theory are supported but large groups of male/female ASDs falling into types B/E are unexplained.

Table 1.

Frequency of control and ASD case populations based on brain type in percentages (Greenberg et al., 2018).

Brain Type	Control Males (%)	Control Females (%)	ASD Males (%)	ASD Females (%)
Extreme E	0.75	2.89	0.30	0.93
E	23.88	40.01	13.37	22.20
B	30.99	29.81	23.92	27.03
S	40.24	25.59	50.98	42.29
Extreme S	4.15	1.69	11.43	7.55

Maintaining relationships and sharing emotions (criteria A; APA, 2013) requires both CE and AE (Smith, 2006) and it's widely accepted ASD is characterized by CE deficits and intact AE (Aaltola, 2014). Furthering this, Smith (2006) suggests ASD individuals become overwhelmed by feeling others' unpredictable emotions (hypersensitive AE) and distressed by their own lack of insight and poor judgement on how to help (impaired CE). The EQ measures CE and AE as both separate and mixed components (Wakabayashi et al, 2006),

so whilst they are recognised as distinct, they are not completely dissociated (Shah, Livingston, Callan & Player, 2019). Greenberg et al. (2018) fail to analyse this despite advocating for intact AE and defective CE in ASD. Intact or hypersensitive AE would lead to imbalanced scores rendering use of the EQ to justify E-S theory as confusing.

CRITERION B

High systemizing abilities captures three of four elements of criterion B (Van der Zee & Derksen, 2021; Baron-Cohen, 2006b; APA, 2013): 1) extreme repetitive behaviour/inflexible need for sameness/rigid routines and 3) abnormally intense/restricted/fixated interests. SM level 8 produces respective corresponding symptoms such as: 1) long duration of repeating phrases/movement sequences 2) meltdowns upon routine change and 3) obsessive analysis of a lawful system (Baron-Cohen, 2006a). Adults with ASD however, do not view their repetitive behaviour as systemizing, they call this 'stimming', whereby repetitive rocking, humming, hand-flapping etc self-soothes and calms the sensory overload of overwhelming environments (Kapp et al., 2019).

E-S theory stipulates a drive to systemize across a range of domains (Baron-Cohen, 2006b), reflected in the SQ (Wakabayashi et al., 2006) using daily life examples (e.g., when I look at a mountain, I think about how it was formed; I like book shops/music stores because they are clearly organised; Baron-Cohen, 2008). The SQ strongly evidences E-S theory (Greenberg et al., 2018), has been genetically correlated with ASD (Warrier et al., 2019) and recommended as a diagnostic tool (Van der Zee & Derksen, 2021). However, Ling, Burton, Salt and Muncer (2009) argue the SQ is more a measure of interest in DIY, technology, topography, and structure than the closed-systems thinking (input-output/x leads to y) characteristic of systemizing (Lawson et al., 2004), and Morsanyi, Primi, Handley, Chiesi and Galli (2012) found the SQ predicts attitude towards, but not actual performance on, mathematics. This reveals the SQ as invalid in measuring actual systemizing ability, or

revealing systemizing as a drive rather than, simply, a preference (Ling et al., 2009), watering down E-S theory.

However, ASD is heritable via high-systemizing parents (Warrier et al., 2019) and Roelfsema et al. (2012) found a higher prevalence of childhood ASD in Eindhoven, which is an IT and technology hub, compared to regions without a science/technology hub, assumably due to high-systemizing parents being attracted to and raising families there. An early-years systemizing preference could be used as a diagnostic tool: Pierce, Conant, Hazin, Stoner and Desmond (2011) showed dynamic geometric images (DGI) or dynamic social images (DSI) to ASD toddlers and controls. If a toddler looked at the DGI for over 69% duration, ASD was positively predicted 100% of the time, supporting the drive to systemize the physical vs the social world. Unfortunately, sex differences were not controlled for (the MTR in ASDs doubled the controls) and male infants prefer physical/mechanical objects to a human face (Connellan, Baron-Cohen, Wheelwright, Batki & Ahluwalia, 2000). Additionally, although ASD toddlers looked longer at DGI than controls, 60% still preferred DSI (Pierce et al, 2011), highlighting ASD shows differing profiles no singular theory fully captures (Pellicano, 2010).

HYPER/HYPO-SENSITIVITY OMISSION

Wheelwright and Baron-Cohen (2011) admit E-S theory fails to account for frequently present element four of criterion B: hyper/hypo reactivity to sensory input (Simmons et al, 2009; APA, 2013). Wheelwright and Baron-Cohen (2011) claim hyper-sensitivity aligns with systemizing via the attention to detail high systemizers exhibit however, visual hyper-sensitivity reveals symptoms incompatible with high systemizing (dislike of bright/dark lights, looking down most of the time, covering eyes from light flashes) whilst hypo-sensitivity symptoms are more compatible with systemizing (fascination with reflective/brightly coloured objects, intense gazing toward objects/people) (Simmons et al., 2009). One can see how hyper/hypo visual sensitivity thus causes social withdrawal or peculiar social behaviour

respectively and Simmons et al. (2009) argue for a theoretical compromise whereby abnormalities in both bottom-up sensory processes and top-down cognitive mechanisms, explain ASD symptoms.

CRITERIA C + D

Empathizing and systemizing are innate core cognitive domains derived from folk psychology and folk physics respectively representing critical areas of functioning (van der Zee & Derksen, 2021). Imbalance between these domains in ASD causes symptoms to appear early in life (criterion C) and seriously impair functioning in even the 'mildest' forms of ASD (criterion D) (Charman et al, 2011). The stage these symptoms are noticed depend not only on individual and environmental factors (APA, 2013), but also upon symptom development (Marshall, 2013). E-S theory stipulates the SM is 'set' therefore doesn't fully capture ASD development.

INSIGHT INTO INTERVENTIONS

Models simplify insight into disorder aetiology, ultimately leading to identifying effective interventions to remediate the disorder's negative effects (Marshall, 2013). The E-S model clearly proposes a CE deficit in ASD: the inability to infer what others think negatively affects emotion recognition, causing confusion and distress (Baron-Cohen, 2008). Using systemizing to improve empathizing, two interventions aiming to teach complex emotion recognition to remediate this are the mindreading DVD and the transporters DVD.

In the mindreading DVD (Goldenfield, Baron-Cohen & Wheelwright, 2005) actors of different ages and ethnicities portraying hundreds of emotions through face and voice are taxonomically categorized for the high-systemizer to study with ease. Because different actors play the same emotions, the user can rehearse recognising and generalizing emotions at their own pace, enabling them to identify emotions correctly more often in the fast-paced social world. Using the DVD for 1-2 hours for 10-15 weeks improved complex emotion recognition in an adult AS/HFA group compared to controls (Golan & Baron-Cohen,

2006). However, there was no evidence within LFA (Zhou, 2019) or improvements in naturalistic settings (Kouo & Egel, 2016). Additionally, the gains (a few more within a maximum 50) in emotion recognition weren't substantial.

In the transporters DVD, actual human faces display a range of basic and complex emotions on the front of animated trains with systematic physical-motion rules to motivate implicit learning of social skills: children aged 4-8 watched either the transporters or Thomas the Tank engine clips (applicable to emotion recognition) (Young & Posselt, 2012). Both interventions improved eye-contact and interest in peers, but only the transporters significantly improved emotion recognition whether IQ was high or low (Young & Posselt, 2012). Parental support and amount of time viewing weren't be ruled out as possible factors, and again, no evidence showed progress in naturalistic settings (Kouo & Egel, 2016). Applying the techniques through practice in real-life contexts would be beneficial to those with ASD.

CONCLUSION

The E-S model captures the ASD dyad more successfully than ED, WCC and ToM, however E-S theory needs to stipulate clearly how CE deficits affect AE and integrate bottom-up sensory processes into the model as these areas are not successfully captured and clearly affect symptoms. The EQ and SQ which are important measures in E-S research, urgently need modification to fit coherently with the model. The E-S model provides useful insight into ASD interventions, giving more tools for those working with people with ASD to remediate emotional distress and confusion in social situations. Whether the mindreading or transporters DVD make a real-life difference depends upon the individual's unique profile of which ASD has many. Teasing language delay and ID apart from ASD is complex, still unresolved and requires further research.

REFERENCES

Aaltola, E. (2014). Affective empathy as core moral agency: Psychopathy, autism and reason revisited. *Philosophical Explorations*, 17(1), 76-92.

American Psychiatric Association (APA). (2013). *Diagnostic and Statistical Manual of Mental Disorders*. (5th ed.). United States of America. American Psychiatric Association.

Asperger, H. (1944). The "autistic psychopaths" in childhood. *Archives of Psychiatry and Nervous Diseases*, 117 (1), 76-136.

Baird, G., Simonoff, E., Pickles, A., Chandler, S., Loucas, T., Meldrum, D., & Charman, T. (2006). Prevalence of disorders of the autism spectrum in a population cohort of children in South Thames: the Special Needs and Autism Project (SNAP). *The lancet*, 368(9531), 210-215.

Baron-Cohen, S. (1990). Autism: A Specific Cognitive Disorder of 'Mind-Blindness'. *International Review of Psychiatry*, 2(1), 81-90.

Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends in cognitive sciences*, 6(6), 248-254.

Baron-Cohen, S. (2006a). The hyper-systemizing, assortative mating theory of autism. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 30(5), 865-872.

Baron-Cohen, S. (2006b). Two new theories of autism: hyper-systemising and assortative mating. *Archives of disease in childhood*, 91(1), 2-5.

Baron-Cohen, S. (2008). *Autism and Asperger syndrome*. Oxford University Press.

Baron-Cohen, S., Wheelwright, S., Lawson, J., Griffin, R., & Hill, J. (2002). The exact mind: Empathising and systemising in autism spectrum conditions. *Handbook of cognitive development*, 491-508.

Black, D. W., & Grant, J. E. (2014). *DSM-5® guidebook: the essential companion to the diagnostic and statistical manual of mental disorders*. American Psychiatric Pub.

Black, D. O., Wallace, G. L., Sokoloff, J. L., & Kenworthy, L. (2009). Brief report: IQ split predicts social symptoms and communication abilities in high-functioning children with autism spectrum disorders. *Journal of autism and developmental disorders*, 39(11), 1613-1619.

Bos, J., & Stokes, M. A. (2019). Cognitive empathy moderates the relationship between affective empathy and wellbeing in adolescents with autism spectrum disorder. *European Journal of Developmental Psychology*, 16(4), 433-446.

Charman, T., Pickles, A., Simonoff, E., Chandler, S., Loucas, T., & Baird, G. (2011). IQ in children with autism spectrum disorders: data from the Special Needs and Autism Project (SNAP). *Psychological medicine*, 41(3), 619-627.

Connellan, J., Baron-Cohen, S., Wheelwright, S., Batki, A., & Ahluwalia, J. (2000). Sex differences in human neonatal social perception. *Infant behavior and Development*, 23(1), 113-118.

Frith, U. (1989). Autism: Explaining the enigma. *British journal of developmental psychology*, 3, 465-468.

Frith, U., & Happé, F. (1994). Autism: Beyond "theory of mind". *Cognition*, 50(1-3), 115-132.

Frith, U., & Mira, M. (1992). Autism and Asperger syndrome. *Focus on Autistic Behavior*, 7(3), 13-15.

Golan, O., & Baron-Cohen, S. (2006). Systemizing empathy: Teaching adults with Asperger syndrome or high-functioning autism to recognize complex emotions using interactive multimedia. *Development and psychopathology*, 18(2), 591-617.

Goldenfeld, N., Baron-Cohen, S., & Wheelwright, S. (2005). Empathizing and systemizing in males, females and autism. *Clinical Neuropsychiatry*, 2(6), 338-345.

Greenberg, D. M., Warrier, V., Allison, C., & Baron-Cohen, S. (2018). Testing the empathizing–systemizing theory of sex differences and the extreme male brain theory of

- autism in half a million people. *Proceedings of the National Academy of Sciences*, 115(48), 12152-12157.
- Hulme, C., & Snowling, M. J. (2009). *Developmental disorders of language learning and cognition*. John Wiley & Sons.
- Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous child*, 2(3), 217-250.
- Kapp, S. K., Steward, R., Crane, L., Elliott, D., Elphick, C., Pellicano, E., & Russell, G. (2019). 'People should be allowed to do what they like': Autistic adults' views and experiences of stimming. *Autism*, 23(7), 1782-1792.
- Kouo, J. L., & Egel, A. L. (2016). The effectiveness of interventions in teaching emotion recognition to children with autism spectrum disorder. *Review Journal of Autism and Developmental Disorders*, 3(3), 254-265.
- Lawson, J. (2003). Depth accessibility difficulties: An alternative conceptualisation of autism spectrum conditions. *Journal for the theory of social behaviour*, 33(2), 189-202.
- Lawson, J., Baron-Cohen, S., & Wheelwright, S. (2004) Empathising and systemising in Adults with and without Asperger Syndrome. *Journal of Autism and Developmental Disorders*. 34, 3, 301-310
- Leslie, A. M., & Frith, U. (1988). Autistic children's understanding of seeing, knowing and believing. *British Journal of Developmental Psychology*, 6(4), 315-324.
- Ling, J., Burton, T. C., Salt, J. L., & Muncer, S. J. (2009). Psychometric analysis of the systemizing quotient (SQ) scale. *British Journal of Psychology*, 100(3), 539-552.
- Loomes, R., Hull, L., & Mandy, W. P. L. (2017). What is the male-to-female ratio in autism spectrum disorder? A systematic review and meta-analysis. *Journal of the American Academy of Child & Adolescent Psychiatry*, 56(6), 466-474.
- Marshall, C. R. (Ed.). (2013). *Current issues in developmental disorders*. Psychology Press.

- Matson, J. L., & Goldin, R. L. (2013). Comorbidity and autism: Trends, topics and future directions. *Research in Autism Spectrum Disorders*, 7(10), 1228-1233.
- Morsanyi, K., & Byrne, R. M. (Eds.). (2019). *Thinking, reasoning, and decision making in autism*. Routledge.
- Morsanyi, K., Primi, C., Handley, S. J., Chiesi, F., & Galli, S. (2012). Are systemizing and autistic traits related to talent and interest in mathematics and engineering? Testing some of the central claims of the empathizing–systemizing theory. *British Journal of Psychology*, 103(4), 472-496.
- Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive function deficits in high-functioning autistic individuals: relationship to theory of mind. *Journal of child Psychology and Psychiatry*, 32(7), 1081-1105.
- Pellicano, E. (2010). The development of core cognitive skills in autism: A 3-year prospective study. *Child Development*, 81(5), 1400-1416.
- Pellicano, E., Maybery, M., Durkin, K. & Maley, A. (2006). Multiple cognitive capabilities/deficits in children with an autism spectrum disorder: "Weak" central coherence and its relationship to theory of mind and executive control. *Development and Psychopathology*, 18, 77-98.
- Pierce, K., Conant, D., Hazin, R., Stoner, R., & Desmond, J. (2011). Preference for geometric patterns early in life as a risk factor for autism. *Archives of general psychiatry*, 68(1), 101-109.
- Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind?. *Behavioral and brain sciences*, 1(4), 515-526.
- Rajendran, G. & Mitchell, P. (2007) Cognitive theories of autism. *Developmental Review*. 27, 224-260

Roelfsema, M. T., Hoekstra, R. A., Allison, C., Wheelwright, S., Brayne, C., Matthews, F. E., & Baron-Cohen, S. (2012). Are autism spectrum conditions more prevalent in an information-technology region? A school-based study of three regions in the Netherlands. *Journal of autism and developmental disorders*, 42(5), 734-739.

Schaepper, M. A., Hauser, M., & Kagadker, F. (2021). *What is intellectual disability?* American Psychiatric Association. Retrieved from <https://www.psychiatry.org/patients-families/intellectual-disability/what-is-intellectual-disability>. Accessed on 13th April 2022.

Shah, P., Livingston, L. A., Callan, M. J., & Player, L. (2019). Trait autism is a better predictor of empathy than alexithymia. *Journal of Autism and Developmental Disorders*, 49(10), 3956-3964.

Simmons, D. R., Robertson, A. E., McKay, L. S., Toal, E., McAleer, P., & Pollick, F. E. (2009). Vision in autism spectrum disorders. *Vision research*, 49(22), 2705-2739.

Smith, A. (2006). Cognitive empathy and emotional empathy in human behavior and evolution. *The Psychological Record*, 56(1), 3-21.

Thurm, A., Farmer, C., Salzman, E., Lord, C., & Bishop, S. (2019). State of the field: Differentiating intellectual disability from autism spectrum disorder. *Frontiers in psychiatry*, 526.

van der Zee, E., & Derksen, J. J. (2021). The power of systemizing in autism. *Child Psychiatry & Human Development*, 52(2), 321-331.

Wakabayashi, A., Baron-Cohen, S., Wheelwright, S., Goldenfeld, N., Delaney, J., Fine, D., ... & Weil, L. (2006). Development of short forms of the Empathy Quotient (EQ-Short) and the Systemizing Quotient (SQ-Short). *Personality and individual differences*, 41(5), 929-940.

Warrier, V., Toro, R., Won, H., Leblond, C. S., Cliquet, F., Delorme, R., ... & Baron-Cohen, S. (2019). Social and non-social autism symptoms and trait domains are genetically dissociable. *Communications biology*, 2(1), 1-13.

Wheelwright, S., & Baron-Cohen, S. (2011). Systemizing and empathizing. *The neuropsychology of autism*, 317-338.

Wing, L. (1981). Asperger's syndrome: a clinical account. *Psychological medicine*, 11(1), 115-129.

Wodka, E. L., Mathy, P., & Kalb, L. (2013). Predictors of phrase and fluent speech in children with autism and severe language delay. *Pediatrics*, 131(4), e1128-e1134.

Young, R. L., & Posselt, M. (2012). Using the transporters DVD as a learning tool for children with autism spectrum disorders (ASD). *Journal of autism and developmental disorders*, 42(6), 984-991.

Zelazo, P. D., Carter, A., Reznick, J. S., & Frye, D. (1997). Early development of executive function: A problem-solving framework. *Review of general psychology*, 1(2), 198-226.

Zhou, Q. (2019). A Review of Interventions to Support the Development of Social Cognition in Children with Autism. *International Journal of Learning and Teaching*, 5(4)