

Therapeutic Interventions involving Mathematical Concepts with a Young Man on the Autism Spectrum

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Summary

- **Human body parts and drawings are apparent in numerical system development and there are therapeutic uses of mathematics.**
- **Earlier contributions described how children and adolescents on the autism spectrum were involved with an assessment and intervention developed by the present author.**
- **They formed faces and human figures from Object Assembly items, drew people and participated in a subitizing task involving the fast apprehension of small numerosities associated with dot and schematic facial feature arrangements.**
- **This extended contribution concerns a young person with a diagnosis of Asperger syndrome and dyslexia but strength in mathematics and computer science.**
- **He began individual sessions, aged 14 years and he attended an educational support centre with outreach assistance followed by a college course in computer science.**

Summary

- **During the sessions, mathematical concepts and ideas such as equality and symmetry were discussed and connected with issues and related anxieties, particularly concerning social interactions.**
- **He was reassessed formally when aged 15 years and after family sessions we met again when he reached 22 years.**
- **His interest in computer science had involved time at a local college followed by university courses with some success and soon after I engaged again with the family when he was 23 years of age, he started a college course offering opportunities for further qualifications.**
- **He had progressed in managing his life and maintained friendships with young people he had met online and personally in adolescence.**

Introduction

- Particular investigations and discussions here concern how mathematics can be used in connection with interpersonal situations.
- In all of my studies, specifically by [Lawson\(1986, 1989, 1990, 1995a, b, 2000a, b, c, 2001a, b, 2002, 2003, 2004, 2005a, b, 2008a, b, c, 2009, 2010, 2011a, b, 2012a, b, 2013a, b, 2014a, b, 2017, 2018\)](#) anxiety was an aspect that was considered and addressed within a therapeutic context.
- In relation to mathematics, anxiety was not apparent as being problematic but it tended to be an issue concerning specific contexts for the young participants on the autism spectrum in my studies.
- [Long\(2011\)](#) highlights discussions by [Hackenberg\(2005a, b\)](#), [Falkenberg\(2005\)](#) and [Hackenberg & Sinclair\(2007\)](#) concerning care, mathematics and teaching/learning.
- [Long\(2011\)](#) considers analogies between caring for people and caring for ideas in mathematics relating to general rules and principles.

Introduction

- Reference is made to **Tahta(1993)** who discusses a contribution by **Weyl-Kailey(1985)**. **Louise Weyl-Kailey** was a French therapist who had been a mathematics teacher and she worked with children on mathematical or family issues sometimes combining these two aspects.
- **An example was given concerning equality in mathematics and its use in a therapeutic context to help a child to feel an equal when engaging with his family.**
- **Mathematics could offer the opportunity for thinking about relational issues and managing them by assisting the development of conceptual understanding and facilitating the use of concepts followed by applications in other contexts.**
- **Todd & Simpson(2016)** - incidentally experiencing anxiety, relative to neutral feelings and anger, impaired the spontaneous calculation of what could be seen by another social agent.

Introduction

- **Morales et al.(2017)** concerning attention bias towards threat and the development and maintenance of fear and anxiety, showed that convergence across attention bias measures might depend on individuals' predispositions, such as temperament.
- **Attention bias convergence across measures might indicate stronger information processing patterns influencing socioemotional outcomes than single task performance.**
- **Pickard et al.(2017)** – social communication(SC) difficulties might be important risk factors for the development of social anxiety(SA).
- **Duvekot et al.(2018)** did not find a bidirectional relationship between ASD core symptom domains and anxiety.
- **Higher anxiety symptom levels might increase the risk of more social communicative impairment over time in children with ASD.**

Introduction

- **Kleberg et al.(2017)** studied eye movements in 25 treatment-seeking adolescents with social anxiety disorder(SAD) and implemented a dimensional assessment of SAD and ASD.
- **After controlling for social anxiety, elevated autistic traits were associated with delayed orienting to eyes presented among distractors whereas, elevated social anxiety levels were associated with faster orienting away from the eyes, after controlling for autistic traits.**
- **In discussing his life in association with autism Edgar Schneider(1999) highlighted his problems with relationships and he indicated that his greatest fear was uncertainty.**
- **Boulter et al.(2014)** suggested a mediating role for Intolerance of Uncertainty(IU) in the relationship between autism spectrum conditions and anxiety.

Introduction

- **Wigham et al.(2015)** - sensory under responsiveness and sensory over responsiveness were associated significantly with repetitive motor and insistence on sameness behaviours, and the relationships were mediated significantly by IU and anxiety.
- **Neil et al.(2016)** - only in those on the autism spectrum did IU remain a significant predictor of children's sensory sensitivities after accounting for anxiety effects.
- **Green et al.(2016)** - atypical responses to sensory stimuli formed a new criterion in DSM-5 for the ASD diagnosis but they were reported in other developmental conditions.
- **Greater sensory dysfunction was associated with increased autism severity, specifically restricted and repetitive behaviours, and behaviour problems, specifically emotional subscore, on teacher and parent Strengths & Difficulties Questionnaires(SDQs) but not with IQ.**

Introduction

- In children and adolescents aged 11-17 years, **Uljarevic' et al.(2016a)** identified three sensory subtypes, namely, sensory adaptive(N=19), sensory moderate(N=29) and sensory severe(N=9).
- **Those from the adaptive subtype had significantly lower anxiety scores when compared with the other two subtypes.**
- A systematic review by **DeBoth & Reynolds(2017)** aimed to synthesize information concerning sensory-based subtypes reported in the literature for children on the autism spectrum.
- **Several different subtyping schemes suggested between 3 to 5 subtypes as an appropriate fit to cover the different patterns of sensory responsivity apparent in such children.**
- **Some studies suggested that a subgroup had typical sensory functioning, and there was a subgroup with significant, global sensory differences.**

Introduction

- **Mixed results were for those in between, who had specific versus global differences in responsivity, that is, hyperresponsivity or hyporesponsivity or sensory seeking, or within specific sensory domains.**
- **Overall, the literature comprised a small number of descriptive studies with little agreement on subtypes.**
- **Uljarevic' & Evans(2017) showed that children with ASD had the highest RRB levels followed by DS, TD MA, and TD CA children.**
- **In those with ASD, higher fear levels related to higher RRB levels.**
- **Similar, although less strong, patterns of associations were found among DS and TD MA children but not in the older TD CA children.**
- **Hence, there was the suggestion of a fear-RRB association in children with ASD, DS, and two groups of TD children.**

Introduction

- **Joyce et al.(2017)** investigated the experience of anxiety and restricted and repetitive behaviours (RRB) in young people with ASD.
- **They could self-report and show insight concerning their RRB.**
- **Schmitt et al.(2018)** noted that inhibitory control deficits might reflect slower execution of stopping processes, or a reduced ability to delay the onset of behavioural responses in contexts of uncertainty.
- **They administered a stop-signal test(SST) to 121 individuals with ASD and 76 age and IQ matched healthy controls, aged 5–28 years.**
- **Inhibitory control deficits in ASD involved failures to delay strategically, behavioural response onset.**
- **Reduced preparatory behavioural control might underpin inhibitory control deficits as well as repetitive behaviours in those on the autism spectrum.**

Introduction

- **Uljarevic' et al.(2016b)** examined the relationships between anxiety and individual characteristics of sensory sensitivity(SS) and IU in mothers of children with ASD.
- The mothers of 50 children completed the Hospital Anxiety and Depression Scale, the Highly Sensitive Person Scale and the IU Scale.
- **Anxiety was associated with SS and IU and, IU was associated with SS.**
- Mediation analyses showed direct effects between anxiety and both IU and SS but a significant indirect effect was found only in the model in which IU mediated between SS and anxiety.
- **Glod et al.(2017)** considered parents of children and adolescents, aged 3-14 years with ASD and those who were typically developing(TD).
- **Data concerning children's sensory experiences were collected through parent reports with the Sensory Profile questionnaire.**

Introduction

- **Information of parental sensory experiences was collected via self-report with the Adolescent/Adult Sensory Profile.**
- **The parents of children with ASD had significantly higher scores than those of TD children for low registration, over responsivity, and taste/smell sensory processing.**
- **Van Etten et al.(2017) investigated the prevalence and pattern of unusual sensory behaviours(USBs) in teenagers with ASD and infants, aged 3–36 months, at risk for ASD.**
- **High-risk infants and teenagers with ASD displayed higher-than-typical prevalence of USBs.**
- **Black et al.(2017) assessed the impact of sensory hypersensitivity on the clinical symptoms of specific phobia, separation anxiety, social anxiety and insistence on sameness(I/S) for autistic and TD children.**

Introduction

- **The parents of 79 children completed questionnaires on their child's difficulties associated with sensory processing, I/S, and anxiety.**
- **Sensory hypersensitivity mediated 67% of the relationship between symptoms of specific phobia and I/S and 57% of the relationship between separation anxiety and I/S.**
- **A relationship was not apparent between sensory hypersensitivity and social anxiety in the autistic or TD children, although social anxiety was correlated with I/S in the autistic participants .**
- **These mediation effects of sensory hypersensitivity were indicated only in autistic children and not in the TD children.**
- **Stevenson et al.(2018) noted that atypical sensory processing in those on the autism spectrum might be related to difficulties in social communication.**

Introduction

- **In their investigation, via a series of tasks concurrently assessing multisensory temporal processes, multisensory integration and speech perception in 76 children, aged 7-16 years, who were and were not on the autism spectrum, they offered behavioural evidence to support such a connection.**
- **Temporal processing abilities in those on the autism spectrum contributed to impairments in speech perception.**
- **This relationship was mediated significantly by their abilities to integrate social information across auditory and visual modalities.**
- **These findings described the cascading effect of sensory abilities in children on the autism spectrum, where temporal processing impacted informative multisensory aspects of social information, which contributed to deficits in speech perception.**

Introduction

- The relationships were found to be specific to the autistic participants, to multisensory but not unisensory integration, and to the processing of social information.
- **Rodgers et al.(2016)** created an adapted version of the RCADS based on empirical evidence of anxiety phenomenology in ASD, which included additional items related to sensory anxiety, intolerance of uncertainty, and phobias.
- The process, involving young people on the autism spectrum aged 8-16 years and their parents, resulted in a new 24 item scale, self and parent report, each with 4 subscales, namely, Performance Anxiety, Uncertainty, Anxious Arousal, and Separation Anxiety, with evidence of good reliability and validity.

Introduction

- **Rodgers et al.(2017)** developed a parent group based manualised treatment programme for young people with ASD, centred on IU.
- **An 8 session programme was created and delivered to 11 parents across 3 treatment groups, 2 recruited via a research data base and 1 via clinical services.**
- **The findings concerning retention, acceptability and feasibility indicated that the parents valued the programme.**
- **Effect size analyses of outcome measures for potential use in a larger trial suggested the programme might be used as a treatment option for young people with ASD and IU.**

Introduction

- A short review by [South & Rodgers\(2017\)](#) concerned atypical sensory function, alexithymia and IU, which appeared closely related to each other as well as being strongly predictive of anxiety in those with ASD.
- [Additionally, they examined the role of the medial prefrontal cortex\(mPFC\) in the regulation of emotional response, in connection with limbic and insula-based networks.](#)
- They suggested that disrupted integration in these networks underpinned habituation difficulties to strong emotional stimuli, resulting in an enhanced threat perception in many ASD individuals.
- Several articles of interest and relevance here concerning anxiety and ASD are from a special issue with an editorial by [South et al.\(2017\)](#).
- The findings by [Taylor et al.\(2018\)](#) indicated a genetic overlap between autistic traits and sensory reactivity(SR) and this observation gave quantitative genetic support to the idea of a strong link between ASD and sensory reactivity(SR).

Introduction

- **Schiltz et al.(2018)** presented findings from a social skills intervention that gave support for the idea that social functioning and depression might be closely related in ASD.
- **Nah et al.(2018)** noted that depression and anxiety are the most common comorbidities in individuals with ASD.
- **The findings showed that 39–46%, of autistic adults scored within the ‘Moderate’ to ‘Extremely Severe’ range on the short-form version of the Depression Anxiety Stress Scales(DASS-21).**
- **Culpin et al.(2018)** examined the hypothesis that ASD diagnosis and traits in childhood were associated with suicidal thoughts, plans and self-harm at 16 years, and that any observed associations were explained by depression at 12 years.

Introduction

- **Approximately 32% of the total estimated association between social communication impairment and self-harm was explained by depressive symptoms at 12 years .**
- **Overall, it was emphasised that social communication impairments formed an important autistic trait in relation to suicidality.**
- **As noted by Byers(2011) when discussing mathematical activity, order and randomness are considered as proto-concepts and they are related to certainty and uncertainty, respectively, with unity showing a tendency to be identified with order and certainty.**
- **When experiencing creative moments, those concerned are assured that something valuable is occurring and the sense of unity involves a different sense of self.**
- **As emphasised by Byers(2011), uncertainty has to be acknowledged and managed within our world and our own experiences.**

Introduction

- **Allman et al.(2005)** have considered the involvement of the **Von Economo neurons(VENs)** in relaying output from the **fronto-insular(FI)** and **anterior cingulate cortex(ACC)** to regions of the **frontal and temporal cortex related to ToM** and where quick intuitions connect with slower more reasoned judgements and they suggest that the **VEN system is impaired for those on the autism spectrum.**
- **Malachini et al.(2016)** considered the etiology of individual differences in the drawings of children in their early years and the etiology of these drawings' longitudinal association with school mathematics.
- **14,760 members of the Twins Early Development Study were assessed on their ability to draw a human figure with the assessment including the number of features, symmetry, and proportionality.**
- **The findings indicated that human figure drawing was moderately stable across 6 months, average $r = .40$.**

Introduction

- **Individual differences in drawing at the age of 4½ years were influenced by genetic, .21, shared environmental, .30, and nonshared environmental, .49, factors.**
- **Drawing was related to later, that is, at age 12 years, mathematical ability, with an average $r = .24$.**
- **This association was explained by genetic and shared environmental factors that also influenced general intelligence.**
- **Some genetic factors, unrelated to intelligence, contributed to individual differences in drawing.**
- **The approach developed by the author here involved related aspects of human figure drawings and mathematics and concerned a range of young people.**
- **Overall, an extension to earlier contributions is presented, involving a specific young man referred to as P. diagnosed with AS.**

Method: Young Person P.

- **Initially P. was described as a young man who had difficulties at home and at school.**
- **He had experienced incidents of bullying and his school refusal resulted in him being withdrawn from mainstream education.**
- **He had been diagnosed with dyslexia and Asperger syndrome but he showed strength in mathematics and computer science.**
- **When P. began participating in individual sessions he was aged around 14 years and apart from his attendance at an educational support centre he was going on trips regularly with outreach staff.**
- **His main interest concerning computer science was pursued by him independently and later via participation in a college course.**
- **He spent a lot of time on his computer at home but he did form some positive relationships at college and via the internet.**
- **He participated in 8 individual sessions with the last session occurring several months after the 7th session.**

Method: Materials

- The tests or parts of tests used have been described in detail in earlier presentations by **Lawson(2003, 2004, 2005a, b, 2008a, c, 2009, 2010, 2011b, 2012a, 2013b, 2014a, b).**
- Specifically, they were the **DAP(Naglieri, 1988), WOND(Rust, 1996), Recall of Digits Forward and Backward(BAS II, Elliot, 1996), Picture Completion(WISC III UK, Wechsler, 1992), WASI(Wechsler, 1999), Dot locations 1&2, Faces, 1&2(CMT, Cohen, 1997), Assessment of Perception of Emotion from Facial Expression(Social Skills Training with Children and Adolescents, Spence, 1995) and Object Assembly Items(Girl & Face(Male), (WISC-R UK, Wechsler, 1976), Manikin, Profile(Female Face) and Hand, (WAIS-R UK, Wechsler, 1981) as well as Cards with Dots and others with Schematic Facial Features.**

Method: Procedure

- **Details concerning the approach designed by the present author including the procedural aspects comprising the test, training and re-test components have been described by Lawson(2003, 2004, 2005a, b, 2008a, c, 2009, 2010, 2011b, 2012a, 2013b, 2014a, b).**
- **Young people including P. were involved in a therapeutic context with specific numerical aspects of mathematics and others that arose during the sessions.**
- **The subitizing task directly linked small numerosities with dots and schematic facial features.**
- **Also, the participants formed faces, human figures and a hand using the Object Assembly pieces and they produced drawings of people.**
- **During these activities, their thoughts and actions concerned such aspects as number, shape, size, length and proportion in an everyday context and in relation to people.**

Method: Procedure

- All of these aspects are associated with specific meanings and applications in mathematics.
- Topics were discussed concerning such ideas as equality, equilibrium, symmetry and balance within mathematical and other contexts.
- Sometimes, the young people spontaneously commented on issues relating to mathematics or people and they made specific connections between them.
- Additionally, the present author as the therapist but formerly a mathematics teacher could intervene and facilitate associations to promote development.
- As indicated here, for participant P. there was longer term follow-up after the cessation of the individual sessions.

Method: Results

- During the initial assessment session P. produced drawings of a man, a woman and himself.
- In overall appearance the figures tended to look like dolls and there were similarities in the characteristics although some distinguishing features were apparent in terms of dress and haircut on the male drawings and a longer hair style on the female.
- On all three depictions the eyes were round and lacked eyebrows and eyelashes.
- Also, there were blobs at the end of each arm on all figures with no clearly defined fingers.
- After further participation, during the 8th session, several months after the 7th session, P. drew carefully a picture of a man, then a woman and finally one of himself.

Method: Results

- He included many details and generally the depictions were well proportioned but rather small although they were more natural in appearance in comparison with his initial larger and less realistic drawings of people.
- This formal reassessment when P. was aged 15 years and some family sessions were followed several years later with another family meeting when P. was aged 22 years.
- He had continued at college with support for dyslexia and participated in a computer science course followed by university courses in this subject with some success.
- I met again with P. in a family session about a year later.
- He was 23 years of age and that academic year he started a computer science course at the local college with the opportunity to gain higher qualifications, obtaining some after participation in the course.

Method: Results

- He completed the RAADS-R, Ritvo et al.(2011) and the discussion and scores on this questionnaire indicated that problematic issues were mainly sensory.
- Overall, he had achieved considerable success concerning personal independence and management of social relationships and situations.
- Later, in order to prepare him for more career opportunities he worked full-time in a supportive workshop and he coped well with tasks involving computing and engineering, sometimes experiencing considerable pressure and managing staff relationships.
- When I met with P. and his mother during the autumn term of the following academic year he had returned to college to study for his GCSE in English and he was considering apprenticeships involving electrical or mechanical engineering.
- He had kept contact with friends who had gone to university and when they returned, sometimes they met together socially.

Method: Results

- I met again with P. and his mother at the beginning of the summer term of that academic year.
- He had been continuing with his course in English in order to take a GCSE in the subject in the May of that year.
- We discussed the two main career paths that he was considering for the following academic year, namely the apprenticeship with a local electric railway company and as an alternative, a course in computer science at the local college which could be part-time or full-time and lead to a degree qualification.
- A friend with whom he had maintained contact with online was due home for the summer vacation period and it was expected that P. would meet with him and others in a social context.
- Overall, the plans for the following academic year were positive as well as some social and family aspects of his life.

Discussion and Conclusion

- **Specific approaches which might facilitate the promotion of abilities in some areas might be used to enhance development in other spheres.**
- **Sommerville et al.(2011)** emphasises that understanding the meaning of actions conveyed by the human body is essential in relation to social reasoning and social interactions in an everyday context.
- Additionally, research involving adults by **Mizuno et al.(2011)** concerns deictic shifting and those on the autism spectrum.
- **This term refers to how the personal pronouns such as ‘I’ and ‘you’ require a speaker/listener to re-map their reciprocal relation to their referent with a reliance on the person speaking the pronoun.**

Discussion and Conclusion

- This deictic shifting might be considered as an underlying and problematic aspect concerning the incorrect production of these pronouns or so-called pronoun reversals such as referring to oneself with the pronoun 'you' as reported in those on the autism spectrum.
- A contribution by Naigles et al.(2016) involved TD toddlers and children on the autism spectrum, with similar language levels.
- Both linguistic and social factors appeared to be implicated in relation to pronoun reversals, and they seemed to occur when the language and social abilities of the children developed asynchronously.
- Pimm & Sinclair(2007) refer to the work of Walkerdine(1988) who notes how Lacan(1977) indicates that the pronouns 'I' and 'you' give an identity to the individual.

Discussion and Conclusion

- **Walkerdine(1988)** highlights the absence of such features and suggests their suppression in mathematical contexts.
- **For those on the autism spectrum, the confusion related to deictic shifting does not present itself when they are involved in mathematics.**
- **Hence, it is an ideal topic to use in approaches aimed at facilitating development in such individuals and to associate it with other topics such those involving social situations to assist them in the formation of appropriate connections.**
- **The approach implemented with the specific young person P. highlighted here appeared to facilitate his progress as well as that of other young people noted in earlier contributions.**
- **Acknowledgements: My grateful thanks to the children and their families as well as school staff and other supportive individuals who contributed to the research presented here.**