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A Preliminary Study: Do the Topography and Frequency of Stereotypy Predict Parent

Play Bid Engagement in Children at High Risk of Autism

A thesis

submitted in fulfilment

of the requirements for the degree

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Abstract

Autism spectrum disorder (ASD) is a complex neurodevelopmental condition characterised by two core features: communication deficits & social interaction difficulties and restricted and repetitive behaviours, interests, or activities (RRBIs). Although numerous studies have been conducted in the social engagement and communication domain, research on RRBIs and remains relatively limited. This thesis aims to conduct a systematic review on stereotypy, a lower-order RBI, to evaluate the current state of knowledge in this domain with a focus on assessment and measurement. Following this review, a pilot study using a novel coding system examines stereotypy and response to parent play bids among children at high risk of ASD, using video samples from a larger grant-funded project. Results of our pilot study suggest this assessment tool may be useful for evaluating learning impacts and to help determine if specialised intervention is needed for lower-order RRBIs. Additionally, the limited findings from our sample participants who were assessed with our tool suggest that stereotypy did not hinder children's responses to parent play bids, thus not needing specialised interventions. Given the limited sample size, findings should be interpreted cautiously. Implications and future research directions are discussed.

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Chapter 1

Introduction

What is ASD

According to the American Psychological Association (n.d.), autism spectrum disorder (ASD) is a neurodevelopmental condition that typically emerges in early childhood (ASD diagnostic criterion C) and is often characterised by persistent difficulties in social communication and interaction with others (ASD diagnostic criterion A). According to the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5, 2013)*, children diagnosed with ASD often exhibit restricted and repetitive patterns of behaviours, interests, or activities (RRBIs) that lack an apparent purpose (ASD diagnostic criterion B). These social interaction challenges and RRBIs may hinder individuals from functioning effectively within their daily lives (ASD diagnostic criterion D). Additionally, these challenges should not be more accurately accounted for by a diagnosis of an intellectual disability or a global developmental delay (ASD diagnostic criterion E).

It is important to note that researchers have not yet fully uncovered the etiology and phenotypology of ASD. Research suggests that a combination of genetic, environmental, and neurodevelopmental factors may contribute to its onset, however, conclusive causal evidence is still lacking (Hodges et al., 2020). Previous research has estimated that approximately 500 genes are affected by de novo mutations contributing to ASD (Ronemus et al., 2014).

Research has also shown that individuals with ASD exhibit lower activation in the brain regions responsible for facial recognition and social recognition compared to typically developing children (Rafiee et al., 2021). Most recently, research further suggests that ASD has four subtypes: social/behavioural class, mixed ASD with developmental delays class, moderate challenges class and broadly affected class (Litman et al., 2025). Additionally, an ASD etiological meta-analysis found substantial heterogeneity across the included studies (Pan et al., 2021). These factors all contribute to the complexity of ASD and increase the difficulty for researchers to fully understand the parameters of this disability classification.

ASD Prevalence

The global prevalence of ASD is increasing rapidly (Zeidan et al., 2022). This increase may be attributed to greater public awareness of ASD and improvements in diagnostic practices. This trend is evident not only in Western countries but also in regions that were previously underrepresented in the literature, such as Qatar (Alshaban et al., 2019) and Nigeria (Chinawa et al., 2016). In the United States, the Centers for Disease Control and Prevention (2024) reported that the prevalence of ASD rose from 1 in 69 children in 2012 to 1 in 36 by 2020. In New Zealand, it was estimated that around 9,000 children under 14 were diagnosed with ASD in 2014-2015 which represents approximately 1.2% of the population. By 2025, the estimated number of children diagnosed with ASD had nearly tripled, reaching approximately 32,000 children or about 3.7% of the population (Ministry of Health Manatū

Hauora, 2025).

ASD Diagnostic Criterion A

According to the *DSM-5* (2013), ASD diagnostic criterion A refers to persistent difficulties in social communication and interaction with others under various circumstances, either currently or in the past. Typical interaction challenges include difficulties demonstrating social-emotional reciprocity, using nonverbal communication for social purposes, and establishing and sustaining social relationships. For example, children with ASD may struggle to make eye contact or interpret body language during everyday communication. They often struggle with initiating or responding to peer-related social engagement and play (Hobson et al., 2012). The wording of the ASD diagnostic criterion A was later refined to clarify that individuals must demonstrate all three types of social-communication difficulties, either currently or historically (American Psychiatric Association, 2022).

Communication difficulties are known to impact social interaction (Palmer et al., 2016). Communication encompasses the sending and receiving of information through both verbal and nonverbal means (Goldstein et al., 2008). Interaction refers to reciprocal exchange between two or more individuals, initiated either by joining an existing activity or starting a new one and terminating when individuals withdraw (Corsaro, 1985). Previous research reports that children with ASD often interact with adults rather than engage with peers, and

often use unconventional approaches, such as physical or prelinguistic behaviour, to initiate social play or stay in close proximity without initiating reciprocal play (Kangas et al., 2011). Individuals with ASD may experience these challenges across their lifespan (Williams et al., 2007).

The severity of the communication and social engagement challenges can vary widely, ranging from the absence of spoken language to difficulties in pragmatic use of language and reduced initiation of peer-related activities. Although numerous studies have been conducted to identify the underlying mechanisms of communication and social interaction challenges, findings remain inconclusive due to the complex interplay among brain regions associated with language and brain functioning (Hodges et al., 2020).

ASD Diagnostic Criterion B

Restricted and repetitive patterns of behaviours, interests, or activities (RRBIs) are another core feature for a diagnosis of ASD. This may be observed as engaging in repetitive patterns of behaviour and/or narrowly focused interests or activities (American Psychiatric Association, 2013). These repetitive repertoires include stereotyped behaviour, insistence on sameness, inflexible adherence to routines, ritualised patterns of verbal or nonverbal behaviour, hyper- or hypo-activity to sensory input. For example, children with ASD may insist on arranging objects in a specific order and become distressed if the sequence is disrupted. To meet the diagnostic criteria for ASD, an individual must exhibit at least two of

these types of RRBIs currently or in the past. Based on the complexity of the repetitive behaviour, RRBIs can be categorised into lower-order RRBIs (e.g., motor stereotypies) and higher-order RRBIs (e.g., insistence on sameness) (Turner, 1999).

Multiple hypotheses have been proposed to explain the underlying mechanisms of RRBIs (Turner, 1999). For example, RRBIs may function as operant behaviour where individuals with ASD maintain the behaviour through self-reinforcement or attention from others. Another explanation is the homeostatic mechanism hypothesis, which suggests that the ascending reticular activating system is chronically overactive in individuals with ASD. Engaging in simple repetitive behaviours may help reduce arousal by hindering further sensory input. It has also been proposed that RRBIs may be explained by weak central coherence or executive dysfunction in individuals with ASD (Turner, 1999). However, none of these hypotheses fully explain the mechanisms underlying RRBIs. Recent research suggests that RRBIs may stem from atypical functioning in various brain regions and circuits; however, conclusive evidence is still lacking (Tian et al., 2022).

Stereotypy

Stereotypy is a subset of RRBIs and refers to invariant repetitive behavioural movements that appear to serve no clear external social purpose (Rapp & Vollmer, 2005). The definition was later expanded by Lanovaz and Sladeczek (2012) to encompass repetitive vocal forms. From a behavioural perspective, stereotypy is conceptualised as an operant

behaviour maintained by automatic positive reinforcement (Rapp & Vollmer, 2005). Common stereotypies can be categorised into different categories: motor stereotypy (e.g., finger rubbing), vocal stereotypy (e.g., echolalia), object-directed stereotypy (e.g., spinning objects) and higher-order or complex stereotypy (e.g., lining up objects based on size or colour) (Wunderlich et al., 2023).

In typically developing children, stereotypy often emerges during early developmental stages and tends to decrease in frequency and intensity as more adaptive behaviours (e.g., playing with toys) develop (Goldman et al., 2008). In contrast, in individuals with ASD, stereotypy is significantly more prevalent and persistent. A review reported that about 90% of individuals with ASD exhibit stereotypies, which represents the highest prevalence compared to other developmental disabilities (Chebli et al., 2016). Importantly, stereotypy is not exclusive to ASD or developmental disabilities. It has been documented in other clinical populations, for example, individuals with obsessive-compulsive disorder (Harris et al., 2008).

ASD Severity

According to *DSM-5* (2013), the severity of ASD is classified into three levels based on the degree of impairment in social communication and/or interaction and the degree of impairment when RRBIs are present. Level 1 (requiring support) refers to individuals who exhibit noticeable difficulties in social communication, such as bizarre responses during

conversations or difficulty initiating social interactions without support. Their persistence of RRBIs may interfere with functioning in some situations. Level 2 (requiring substantial support) refers to individuals who exhibit marked social communication difficulties in both verbal and nonverbal communication and limited interactions or abnormal responses even with support from others. RRBIs are more frequent and obvious than at Level 1, and they may exhibit distress when switching to other activities or changing routine. Level 3 (requiring very substantial support) refers to individuals who exhibit severe social communication difficulties in both verbal and nonverbal communication and extremely limited interaction or minimal response to others, even with significant support. Their RRBIs significantly interfere with all areas of functioning and exhibit extreme distress when switching to other activities or interests than individuals at Level 2.

Communication & Interaction Deficits and RRBIs Impact

ASD core features, communication challenges, social interaction difficulties and RRBIs, may result in profound challenges for many autistic individuals throughout their lifespan. Different communication styles may hinder autistic individuals from establishing or maintaining relationships with others which in turn may lead to experiences of loneliness and limited social relationship bonding (Lisboa White et al., 2024). These social barriers may contribute to a greater likelihood of experiencing anxiety and depression in their academic journey due to having difficulties socialising with their peers (Davis et al., 2021). Given these

potential challenges, individuals with complex communication needs often require specialised support (e.g., augmentative and alternative communication) to develop expressive communication skills before participating in social and academic contexts (Biggs et al., 2018). Additionally, a recent survey showed that the ASD population experiences higher communication apprehension compared to their colleagues which makes them more anxious in the workplace when the communication situation is unpredictable (Cardon, 2023).

In addition to communication challenges and their impact on social engagement, restricted and repetitive behaviour patterns may also lead to health-related concerns. For example, selective eating habits associated with RRBIs place autistic individuals at greater risk of obesity and oral health issues compared to their nonautistic peers (Ferrazzano et al., 2020; Şengüzel et al., 2021). Russell et al. (2019) found that all RRBIs subtypes (rituals or sameness behaviour, compulsive behaviour, stereotypic behaviour, self-injurious behaviour) were positively correlated with anxiety among children with ASD. Additionally, Hundley et al. (2016) also reported that the repetitive sensory motor behaviours, a subtype of RRBIs categorised by the Autism Diagnostic Interview-Revised (ADI-R; Lord et al. 1994), were positively correlated with sleep problems. These findings highlight that RRBIs not only impact their direct behavioural features but may also extend to affect other areas of daily life.

Gap in Previous Research

Despite extensive research being conducted on the negative impact of ASD for

individuals and their families, as well as on its etiology and interventions, there is limited information on the relationship between the two core features of autism and how they interplay and impact on learning opportunities. Although previous research has shown that higher-order RRBIs (e.g., circumscribed interests) may hinder social engagement (Klin et al., 2007), it remains unclear whether lower-order RRBIs, particularly stereotypy, restrict opportunities for social play. Notably, a previous review reported that the majority of included studies (25 out of 27) assessing RRBIs relied on indirect measures (Leekam et al., 2011). Therefore, it remains unknown whether direct assessment methods would yield different findings.

A few previous studies have examined the relationship between stereotypy and social engagement in children with autism. Lee et al. (2007) found that increasing peer social engagement may reduce stereotypic behaviours among children with ASD. Lang et al. (2014) found that teaching autistic children play skills could reduce their stereotypic behaviours. Existing research has primarily focused on how social engagement can be used to reduce stereotypic behaviours. However, the reverse direction, whether stereotypic behaviours themselves directly hinder social engagement remains unclear.

Purpose of the Study

Given the increasing prevalence of ASD and its impact on individuals across the lifespan, it is imperative to fully evaluate the core diagnostic features of ASD (RRBIs and

challenges in social interaction). Although numerous studies have been conducted in the social engagement domain, research on RRBIs remains relatively limited. To address and fill the gaps in previous research, this thesis aims to conduct a systematic review on stereotypy, specifically lower-order RRBIs. Followed by a preliminary study to examine the use of a novel direct assessment tool to help evaluate the relationship between stereotypy and social interaction during parent and child play using a large data set from a grant funded project.

Chapter 2

Systematic Literature Review

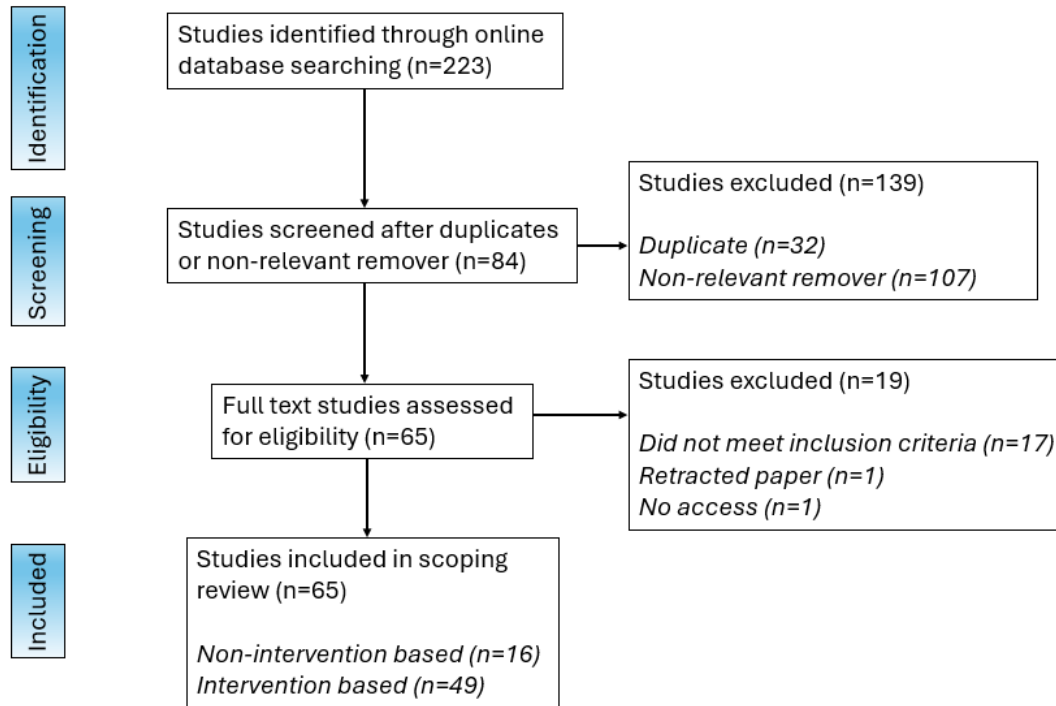
Method

Literature Search Strategy

In this systematic review, the literature was systematically searched across 83 databases that the University of Waikato subscribes to via ProQuest, including psychology- or education-related databases including ERIC and Psychology Collection. The search term: noft(stereotypy) AND noft(auti*) was applied in all databases. Searches were limited to English language and peer-reviewed articles. The search was conducted in July 2024 and a total of 223 articles were retrieved. Titles and abstracts were initially screened to determine whether the studies were relevant for full-text screening. Irrelevant and duplicate articles were removed. The eligibility of the remaining studies was then assessed through full-text review by the first rater, a psychology master's student, based on predefined inclusion and exclusion criteria. Studies that did not meet the criteria after full-text assessment were removed and those that met the criteria were included in the review. See Figure 1 for a detailed diagram of the search process.

Figure 1

PRISMA Flow Diagram of the Study Selection Process



Note. This flowchart demonstrates the study selection procedure, according to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA).

Inclusion and Exclusion Criteria

During the full screening process, the literature was selected based on the following criteria:

- (1) Papers must focus on motor and/or vocal stereotypies as a primary dependent variable, either as a target of intervention, assessment, or description.
- (2) At least one participant had a formal diagnosis of ASD. (a) In single case design studies, participants without a formal ASD diagnosis and those diagnosed with other disorders (even if they demonstrate stereotypic behaviours) will not be discussed in the results table. (b) In group design studies, if some participants do not have an

ASD diagnosis (e.g., control group or comparison group), the study will be included only if data specific to participants with ASD can be disaggregated (participants in the control group without ASD does not meet this requirement). Otherwise, the study will be excluded.

- (3) The study must include at least one participant under the age of 12 as the subsequent pilot study in this thesis primarily focuses on children. (a) In single case design studies, participants over the age of 12 will not be discussed in the results table. (b) In group research design, if participants over the age of 12 are included, the study will first be reviewed to determine whether subgroup results for participants under 12 are reported. If age-specific data are disaggregated, only results for subgroup participants under 12 will be included in the table. If age groups are not separated, the study will still be included, however, reported with a caveat.
- (4) Papers must be peer-reviewed and published in academic journals from January 2014. Dissertations, theses or any all forms of grey literature will be excluded.
- (5) Papers needed to be written in English. Any language other than English will be excluded.
- (6) Papers focusing on neuroscience or any types of review (e.g., systematic review or narrative review) or meta-analysis will be excluded.

After applying the inclusion and exclusion criteria, a total of 16 non-intervention-based

studies and 49 intervention-based studies (including 44 single case design studies and 5 group design studies) were included in this review.

For screening reliability, a second master's student in psychology independently screened the same 223 articles using the same criteria. The interrater reliability was calculated as the percentage of agreements between the two reviewers across all screening decisions (both inclusion and exclusion) divided by the total number of articles and multiplied by 100. Initial agreement for included and excluded papers was 91.4% ($n = 204$). Disagreements were resolved through discussion until there was a final consensus (100% agreement) was reached by the independent reviewers.

Data Extraction

A total of 16 non-intervention-based studies met the inclusion criteria and were reviewed based on the following variables: (1) participant characteristics (including numbers of the participants who met the inclusion criteria, their age, gender, ethnicity and diagnosis), (2) assessment of stereotypy (including assessment type, measurement type or measurement tool, and assessor), (3) types of stereotypies (including topography), and (4) main finding. More details about the included non-intervention-based studies can be found in Table 1 below.

A total of 49 intervention-based studies met the inclusion criteria and were reviewed based on the following variables: (1) participant characteristics (including numbers of the participants who met the inclusion criteria, their age, gender, ethnicity and diagnosis), (2)

assessment of stereotypes (including how stereotype was initially identified prior to participant referral, the method used to assess stereotype prior to participant referral, dependent variable, topography, intervention assessment type, measurement type or measurement tool, and their function as identified through functional analysis), (3) intervention strategies, dosage, and the agent responsible for implementing the interventions, (4) outcome (whether the intervention was effective in reducing stereotypic behaviours), and (5) the quality of the study. More details about the included intervention-based studies can be found in Table 2 below.

Quality Evaluation

The first rater evaluated the quality of all 16 non-intervention-based studies using the standard described in the Appraisal Tool for Cross-Sectional Studies (Downes et al., 2016). The Appraisal Tool for Cross-Sectional Studies (Downes et al., 2016) evaluates the quality of studies based on rigor of their methodology, results and discussion. Similarly, the quality of all 49 intervention-based studies was evaluated by the first rater using the standard described by Reichow et al. (2011). Reichow et al. (2011) evaluate the strength of ASD related intervention research, including both group and single case designs, based on methodological rigor and reproducibility.

Table 1

Summary of Non-Intervention-Based Papers Met the Inclusion Criteria

Study	Participant Characteristics	Assessments of Stereotypies	Types of stereotypies	Results
Brierley et al. (2021) **	<i>N</i> = 634 (496 males; 138 females) <i>Ages^a</i>: 1:6 to 21:11 (<i>M</i> = 10:2) <i>Diagnostic</i>: All autism <i>Ethnicity</i>: Aboriginal, Arab, Asian, Black, Caucasian, Hispanic, Jewish***	<i>Assessment type</i>: Indirect assessment <i>Measurement tool</i>: Repetitive Behavior Scale-Revised <i>Agent</i>: Parents	<i>Types</i>: Motor and vocal stereotypy <i>Topography</i>: Not specified	IQ and age were both negatively correlated with stereotypy.
Feta et al. (2021) **	<i>N</i> = 50 (39 males; 11 females) <i>Ages^a</i>: 5 to 15 (<i>M</i> = 5:0) <i>Diagnostic</i>: All autism <i>Ethnicity</i>: Unknown	<i>Assessment type</i>: Indirect assessment <i>Measurement tool</i>: Repetitive Behavior Scale-Revised <i>Agent</i>: Patients' caregivers	<i>Types</i>: Motor and vocal stereotypy <i>Topography</i>: Not specified	ID was positively correlated with stereotypic behaviours. Short Sensory Profile scores were negatively correlated with stereotypic behaviours. Among the Short Sensory Profile subscales, under-responsive/seeks sensation and visual/auditory sensitivity were significantly negatively correlated with stereotypic behaviours.

Study	Participant Characteristics	Assessments of Stereotypies	Types of stereotypies	Results
Gladfelter & VanZuiden (2020)	<i>N</i> = 11 (10 males; 1 female) <i>Ages^a</i> : 4:8 to 10:5 (<i>M</i> = 8:6) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessments</i> : Direct assessment <i>Measurement type</i> : Continuous event recording <i>Agent</i> : Experimenters	<i>Types</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations, echolalia	Participants exhibited a lower frequency of vocal stereotypy in the storytelling condition compared to the play-based condition.
Grossi et al. (2021) **	<i>N</i> = 67 (58 males; 9 females) <i>Ages^a</i> : 7:1 to 24:10 (<i>M</i> = 14:2) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessments</i> : Direct assessment <i>Measurement type</i> : Continuous event recording <i>Agent</i> : Experimenters	<i>Types</i> : Motor and vocal stereotypy <i>Topography</i> : Finger tapping, hand waving, repetitive limb movements, body rocking, toe walking, jumping while walking, running, object touching or mouthing, body parts or objects licking, noncontextual or nonfunctional repetitive vocalisations, echolalia	The mean number of different restricted and repetitive behaviours among participants was 11.6 (range 1 to 33). The number of stereotypical patterns was positively correlated with ASD severity.

Study	Participant Characteristics	Assessments of Stereotypies	Types of stereotypies	Results
Gundogdu et al. (2023)	<i>N</i> = 46 (38 males; 8 females) <i>Ages^a</i> : 3 to 9 (<i>M</i> = 5:3) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessment type</i> : Indirect assessment <i>Measurement tool</i> : Aberrant Behavior Checklist <i>Agent</i> : Parents	<i>Types</i> : Motor and vocal stereotypy <i>Topography</i> : Not specified	Stereotypy was positively correlated with sensation seeking and visual processing.
Jasim & Perry (2023) **	<i>N</i> = 2758 (2383 males; 375 females) <i>Ages^a</i> : 4 to 18 (<i>M</i> = unknown) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessment type</i> : Indirect assessment <i>Measurement tool</i> : Repetitive Behavior Scale-Revised <i>Agent</i> : Parents	<i>Types</i> : Motor and vocal stereotypy <i>Topography</i> : Not specified	No significant sex differences were observed on stereotypy scales. Children under 12 exhibited significantly more stereotypic behaviours than adolescents. Lower IQ groups showed higher stereotypy scores (except on the ritualistic/sameness subscale).
Kelly & Reed (2021)	<i>N</i> = 24 (17 males; 7 females) <i>Ages^a</i> : unknown (<i>M</i> = 6:6) <i>Diagnostic</i> : 12 autism (12 males) and 12 typical developed (5 males; 7 females) <i>Ethnicity</i> : Unknown	<i>Assessment type</i> : Indirect assessment <i>Measurement tool</i> : Gilliam Autism Rating Scale-II <i>Agent</i> : Parents	<i>Types</i> : Motor and vocal stereotypy <i>Topography</i> : Not specified	Stereotypic behaviour was positively correlated with over-selectivity. After controlling for other predictors, IQ was no longer significantly associated with over-selectivity.

Study	Participant Characteristics	Assessments of Stereotypies	Types of stereotypies	Results
Lanzarini et al. (2021)	<i>N</i> = 35 (26 males; 9 females) <i>Ages</i>^a: 1 to 11 (<i>M</i> = 4:4) <i>Diagnostic</i>: All autism <i>Ethnicity</i>: Unknown	<i>Assessments</i>: Direct assessment <i>Measurement type</i>: Not clear enough <i>Agent</i>: Experimenters	<i>Types</i>: Motor and vocal stereotypy <i>Topography</i>: Head/trunk/shoulders scrunching, arching the back, arm/leg flapping, crossing the arms on the chest, stamping the feet, hand/finger shaking, tapping, waving, clapping, opening-closing, twirling the hand or fingers, shaking, tapping, twirling an object, pacing, jumping, running, skipping or spinning, covering the ears, mouthing, smelling, rubbing the eyes, tapping the chin, banging the arms against the body, lateral-gaze, noncontextual or nonfunctional repetitive vocalisations, echolalia	Approximately 80% of the participants exhibited vocal stereotypy. Among these participants, 60% exhibited non-communicative vocal stereotypic behaviours which occurred more frequently than other subtypes. Non-communicative vocalisations were more likely to be observed among nonverbal participants whereas echolalia was more likely to be observed among verbal participants.

Study	Participant Characteristics	Assessments of Stereotypies	Types of stereotypies	Results
Lydon et al. (2015) *	<i>N</i> = 4 (4 males) <i>Ages^a</i> : 4 to 10 (<i>M</i> = 7:0) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessments</i> : Direct assessment <i>Measurement type</i> : Continuous event recording <i>Agent</i> : Experimenters	<i>Types</i> : Motor stereotypy <i>Topography</i> : Chin pushing, ear pressing or covering, face covering, facial grimacing, hair rubbing, head nodding or shaking, teeth touching, tongue movements, finger sucking, hand clapping, squeeze, pressing, rubbing, lips pressing, skin and nail picking, skin pulling, body rocking, bouncing, writhing, jumping, limb swinging, pacing, shoulder shrugging, squeezing or tapping objects	There was a limited association between physiological arousal (heart rate) and stereotypy.
Reda et al. (2021)	<i>N</i> = 40 (27 males; 13 females) <i>Ages^a</i> : 2 to 5 (<i>M</i> = unknown) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessment type</i> : Indirect assessment <i>Measurement tool</i> : Autism Diagnostic Interview-Revised <i>Agent</i> : Caregivers	<i>Types</i> : Motor and vocal stereotypy <i>Topography</i> : Not specified	Stereotypy was negatively correlated with Short Sensory Profile scores (including most subscales except low energy/weak and visual/auditory sensitivity).

Study	Participant Characteristics	Assessments of Stereotypies	Types of stereotypies	Results
Reis et al. (2023) **	<i>N</i> = 51 (34 males; 17 females) <i>Ages^a</i> : unknown (<i>M</i> = 8:1) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessment type</i> : Indirect assessment <i>Measurement tool</i> : Social Communication Questionnaire <i>Agent</i> : Parents	<i>Types</i> : Motor stereotypy <i>Topography</i> : Not specified	Participants whose parents were not married exhibited more stereotypic behaviours than those whose parents were married. Most children (38 out of 40) taking risperidone exhibited higher levels of stereotypy behaviours.
Sannar et al. (2018) **	<i>N</i> = 106 (81 males; 25 females) <i>Ages^a</i> : 4 to 20 (<i>M</i> = 13:0) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessment type</i> : Indirect assessment <i>Measurement tool</i> : Aberrant Behavior Checklist <i>Agent</i> : Parents and caregivers	<i>Types</i> : Motor and vocal stereotypy <i>Topography</i> : Not specified	Stereotypic behaviours were negatively correlated with sleep duration during the final five nights of hospitalisation.
Stephenson et al. (2023)	<i>N</i> = 481 (381 males; 100 females) <i>Ages^a</i> : 2 to 5 (<i>M</i> = unknown) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessment type</i> : Indirect assessment <i>Measurement tool</i> : Autism Spectrum Rating Scales <i>Agent</i> : Parents and caregivers	<i>Types</i> : Motor stereotypy <i>Topography</i> : Not specified	Females exhibited lower stereotypy scores on ASRS compared to males.

Study	Participant Characteristics	Assessments of Stereotypies	Types of stereotypies	Results
Termine et al. (2021) **	<i>N</i> = 27 (24 males; 13 females) <i>Ages^a</i> : age details unknown (<i>M</i> = 14) <i>Diagnostic</i> : All autism <i>Ethnicity</i> : Unknown	<i>Assessments</i> : Direct assessment <i>Measurement type</i> : Video-based observational <i>Agent</i> : Experimenters	<i>Types</i> : Motor stereotypy <i>Topography</i> : Eye blinking, shoulder shrugging, neck bending, taring, throat clearing (possible tics diagnosed as stereotypies)	Stereotypies were more likely to co-occur with tics, particularly in individuals with more severe ASD.
Wunderlich et al. (2020) *	<i>N</i> = 1 (1 male) <i>Ages^a</i> : 9:0 <i>Diagnostic</i> : Autism <i>Ethnicity</i> : Unknown	<i>Assessments</i> : Direct assessment <i>Measurement type</i> : Continuous duration recording <i>Agent</i> : Experimenters	<i>Types</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations,	The function of vocal stereotypy (automatic reinforcement) remained stable for more than one year.
Zhao et al. (2021) **	<i>N</i> = 43 (gender details unknown) <i>Ages^a</i> : 6 to 13 (<i>M</i> = unknown) <i>Diagnostic</i> : 20 autism and 23 typical developed <i>Ethnicity</i> : Unknown	<i>Assessments</i> : Direct assessment <i>Measurement type</i> : Continuous kinematic measurement <i>Agent</i> : Experimenters	<i>Types</i> : Motor stereotypy <i>Topography</i> : Head movements	Participants with ASD exhibited significantly more motor stereotypic behaviours (e.g., head movements and rotation) during face-to-face interaction compared to typically developing participants.

Note. * Indicates that more participants were included in the paper than listed. However, those participants did not meet the inclusion criteria and

therefore they were not listed or discussed on the table. ** Indicates that results for children under 12 were not disaggregated from the overall group and therefore include data from participants over 12. Ages^a expressed as years: months. *** Indicates that not all participants' ethnicity data were available.

Table 2*Summary of Intervention-Based Papers Met the Inclusion Criteria*

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Barszcz et al. (2021)	<i>N</i> = 4 (2 males; 2 females) <i>Ages</i>: 5:1 to 8 (<i>M</i> = 5:11) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Direct observation by clinical service provider <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Vocal stereotypy <i>Topography</i>: Noncontextual or nonfunctional repetitive vocalisations <i>Intervention Assessment</i>: Direct observation <i>Measurement type</i>: Continuous duration recording <i>FA</i>: Not conducted	<i>Strategy</i>: Traditional RIRD and modified RIRD <i>Dosage</i>: 5 days per week, 5 mins per session <i>Agent</i>: Experimenter	Traditional and modified RIRD were both effective in reducing vocal stereotypy. Modified RIRD was more effective than traditional RIRD.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Boyle et al. (2018)	<i>N</i> = 1 (1 male) <i>Ages</i> : 5:0 <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor stereotypy <i>Topography</i> : Door opening and closing <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : FCT, NCR, NCR + FCT and NCR + Signal FCT <i>Dosage</i> : 10 mins per session <i>Agent</i> : Experimenter	None of the intervention strategies were clinically effective. The percentage of exhibited stereotypic behaviours remained relatively stable across all conditions before and after intervention.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Callahan et al. (2023)	<i>N</i> = 3 (3 males) <i>Ages</i> : 3 to 9 (<i>M</i> = 6:4) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Direct observation by caregivers <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor and vocal stereotypy <i>Topography</i> : Finger manipulation or tensing, pacing, saliva play, arm flapping, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : RIRD <i>Dosage</i> : 20 mins per session <i>Agent</i> : Experimenter	A multiple-schedule arrangement with RIRD reduced stereotypic behaviours effectively and rapidly.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Cariveau et al. (2016)	<i>N</i> = 2 (1 male; 1 female) <i>Ages</i>: 7 to 9 (<i>M</i> = 8:0) <i>Diagnosis</i>: ASD, Fragile X syndrome <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Scratching fingernails on tables, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: Trial-based event recording <i>FA</i>: Not conducted	<i>Strategy</i>: Discrete trial and progressive prompt delay. <i>Dosage</i>: 2-3 days per week, 3-11 sessions per day <i>Agent</i>: Experimenter	Participants exhibited a lower frequency of stereotypic behaviours in the short (2 seconds) intervention condition but not in the progressive (2-20 seconds) or long (20 seconds) conditions.	Adequate

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Cividini-Motta et al. (2019) *	<i>n</i> = 3 (1 male; 2 females) <i>Ages</i>: 5 to 8 (<i>M</i> = 6:0) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Flipping and spinning of objects, hand flapping, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: Continuous duration recording <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: RIRD, DRA and RIRD+DRA <i>Dosage</i>: 1-2 days per week. 2 hours per session <i>Agent</i>: Experimenter	RIRD and RIRD+DRA both effectively decreased stereotypic behaviours. DRA effectively decreased stereotypic behaviours for only one participant.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Cook & Rapp (2020)	<i>N</i> = 5 (5 males) <i>Ages</i> : 4 to 7 (<i>M</i> = 5:5) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Direct observation by caregivers <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor and vocal stereotypy <i>Topography</i> : Rotating objects, rubbing or pressing fingers, finger posturing, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Momentary time sampling (10s interval) <i>FA</i> : Not conducted	<i>Strategy</i> : DRA <i>Dosage</i> : 3-4 days per week, 5 sessions per day <i>Agent</i> : Experimenter	DRA effectively reduced the frequency of stereotypic behaviours for 4 out of 5 participants.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
DeRosa et al. (2019) *	<i>n</i> = 2 (2 males) <i>Ages</i> : 6 to 9 (<i>M</i> = 7:6) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor stereotypy <i>Topography</i> : Finger posturing, ear plugging, hand flapping, object tapping <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : RIRD and response blocking <i>Dosage</i> : 5 days per week, 5 sessions per day (1 hour per day) <i>Agent</i> : Experimenter	Both RIRD and response blocking effectively decreased stereotypic behaviours. RIRD appeared to be more effective.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Edwards et al. (2018) *	<i>n</i> = 2 (2 males) <i>Ages</i> : 4 to 7 (<i>M</i> = 5:6) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Direct observation by parents <i>Measurement tool</i> : Behavior Problems Inventory <i>Dependent variable</i> : Motor stereotypy <i>Topography</i> : Mouthing, spinning, posturing, bursts of running, head hitting, pacing, body movements, scratching <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Not conducted	<i>Strategy</i> : Backward Chaining <i>Dosage</i> : 5 days per week, 2 hours per day, 5 mins per session <i>Agent</i> : Experimenter	Both participants exhibited decreases in stereotypic behaviours in the play contexts following the intervention.	Adequate

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Esposito et al. (2021)	<i>N</i> = 3 (3 males) <i>Ages</i> : 5 to 7 (<i>M</i> = 5:9) <i>Diagnosis</i> : ASD, ID <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor stereotypy <i>Topography</i> : Clapping, belly movements, swinging on a chair, hand flapping, face rubbing, swinging wires or hair, moving hands and objects near the eyes <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : 10s partial interval <i>FA</i> : Not conducted	<i>Strategy</i> : Stimulus-stimulus pairing and response blocking <i>Dosage</i> : 400 seconds per session per week <i>Agent</i> : Experimenter	Stimulus-stimulus pairing combined with response blocking was effective in reducing stereotypic behaviours.	Weak

Study	Participant Characteristics	Assessments of Stereotypes	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Esposito et al. (2021)	<i>N</i> = 1 (1 male) <i>Ages</i> : 7:0 <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Direct observation by caregivers and school teachers <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Latency recording, 15s partial interval <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : RIRD <i>Dosage</i> : 2 sessions per week (overall 32 weeks), 5 mins per session <i>Agent</i> : Experimenter	Stimulus discrimination (presentation of the target stimulus or removal of the non-target stimulus) reduced stereotypic behaviours.	Adequate

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Falligant & Dommestrup (2020)	<i>N</i> = 1 (1 male) <i>Ages</i> : 12:0 <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor stereotypy <i>Topography</i> : Tapping hands on face/legs/table/items, flapping hand near face <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : RIRD <i>Dosage</i> : 5 days per week, 5 hours per day <i>Agent</i> : Experimenter	RIRD and contingent access to stereotypy were effective in reducing motor stereotypic behaviours under both S+ and S- conditions.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Gauthier et al. (2020) *	<i>n</i> = 1 (1 female) Ages: 8:0 Diagnosis: ASD Ethnicity: Unknown	<i>Identification</i> : Direct observation by clinical service provider <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : RIRD <i>Dosage</i> : 5 mins per session <i>Agent</i> : Experimenter	RIRD effectively reduced vocal stereotypy even when treatment integrity was as low as 33%.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Gehrman et al. (2017)	<i>N</i> = 1 (1 male) <i>Ages</i> : 6:0 <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Direct observation by parents <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor stereotypy <i>Topography</i> : Hand flapping <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : 10s partial interval <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : Resetting DRO and non-resetting DRO <i>Dosage</i> : 5 mins per session <i>Agent</i> : Experimenter	Both resetting and non-resetting DRO were equally effective in reducing motor stereotypy. The participant preferred the resetting DRO.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Gerow et al. (2019)	<i>N</i> = 1 (1 female) <i>Ages</i> : 2:8 <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Caucasian	<i>Identification</i> : Direct observation by parents <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : 10s partial interval <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : Competing stimulus, DRA and response blocking <i>Dosage</i> : 1-2 days per week, 2-4 sessions per day, 5 mins per session <i>Agent</i> : Trained parents	Parent implemented intervention (a combination of DRA, response blocking and completing stimulus) effectively reduced motor stereotypy.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Gibbs et al. (2018)	<i>N</i> = 2 (1 male; 1 female) <i>Ages</i>: 4 to 7 (<i>M</i> = 5:6) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Direct observation by clinical service provider <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Vocal stereotypy <i>Topography</i>: Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 10s partial interval <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: RIRD and matched stimulation+RIRD <i>Dosage</i>: No more than 4 sessions per day, 30 mins per session <i>Agent</i>: Experimenter	Both RIRD and matched stimulation+RIRD were effective in reducing vocal stereotypy. Matched stimulation+RIRD was more effective than RIRD alone.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Gibney et al. (2020) *	<i>n</i> = 1 (1 female) Ages: 12:0 Diagnosis: ASD Ethnicity: Unknown	<i>Identification</i> : Direct observation by school teachers <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations, echolalia <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : RIRD and NCR-M <i>Dosage</i> : 1 hour per session <i>Agent</i> : Experimenter	Neither RIRD nor NCR-M was effective in reducing vocal stereotypy for the participant under 12. However, both interventions were effective for participants over 12.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Goldman et al. (2021)	<i>N</i> = 4 (4 males) <i>Ages</i>: 7 to 8 (<i>M</i> = 7:6) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Hand mouthing, foot stomping, hand flapping, objects tapping, hand wringing, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: Continuous duration recording <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: DR, token system and concurrent chain schedule <i>Dosage</i>: 10-30 mins per session, no more than 2 sessions per day <i>Agent</i>: Experimenter	Physical activity interventions showed limited effectiveness in reducing stereotypic behaviours.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Greenberg et al. (2016)	<i>N</i> = 4 (4 males) <i>Ages</i> : 5 to 11 (<i>M</i> = 6:9) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor and vocal stereotypy <i>Topography</i> : Hand flapping, posturing, palilalia, rocking, pacing <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : 10s whole interval <i>FA</i> : Not conducted	<i>Strategy</i> : Stimulus control and modelling <i>Dosage</i> : Every 1-2 sessions per week, 15 mins per session <i>Agent</i> : Experimenter	Stereotypic behaviours were significantly reduced following the intervention.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Labrèche & Lanovaz (2019)	<i>N</i> = 3 (3 males) <i>Ages</i>: 7 to 11 (mean age unknown) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Vocal stereotypy <i>Topography</i>: Noncontextual or nonfunctional repetitive vocalisations, repetitive scripted vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: Latency recording, 10s partial interval <i>FA</i>: Not conducted	<i>Strategy</i>: DRO <i>Dosage</i>: Unknown <i>Agent</i>: Experimenter	DRO was effective. The frequency of vocal stereotypy was reduced to zero.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
LaFrance et al. (2015)	<i>N</i> = 1 (1 male) <i>Ages</i>: 5:0 <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor stereotypy <i>Topography</i>: Body rocking, walking, running rapidly back and forth or side-to-side, jumping up and down, hand and finger movements <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 10s partial interval <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: Auditory integration therapy <i>Dosage</i>: 35 hours per week, 5 mins per session (with additional 5 mins pre-session and 5 mins post-session) <i>Agent</i>: Experimenter	Auditory integration therapy was not effective in reducing stereotypic behaviours (the frequency even increased).	Weak

Study	Participant Characteristics	Assessments of Stereotypes	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Ledbetter-Cho et al. (2017)	<i>N</i> = 2 (1 male; 1 female) <i>Ages</i>: 9 to 11 (<i>M</i> = 10:0) <i>Diagnosis</i>: ASD, ADHD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Vocal stereotypy <i>Topography</i>: Repetitive scripted vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 5s partial interval <i>FA</i>: Not conducted	<i>Strategy</i>: Video-enhanced activity schedules <i>Dosage</i>: 2-4 times per day and session duration varied depending upon how quickly the intervention worked <i>Agent</i>: Experimenter	The frequency of stereotypic behaviours did not increase. However, stereotypy was not the primary focus of the study.	Strong
Ledbetter-Cho et al. (2023) *	<i>n</i> = 2 (2 males) <i>Ages</i>: 8 to 9 (<i>M</i> = 8:6) <i>Diagnosis</i>: ASD, ID, speech impairment <i>Ethnicity</i>: Asian, Caucasian	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Not specified <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 10s partial interval <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: Visual activity schedules and video modelling <i>Dosage</i>: 2-3 days per week, 1-2 sessions per day, 2-10 mins per session <i>Agent</i>: Trained teacher	Both participants exhibited limited decreases in stereotypic behaviours following the intervention.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Llinas et al. (2022)	<i>N</i> = 2 (1 male; 1 female) <i>Ages</i>: 2 to 3 (<i>M</i> = 2:6) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Caucasian	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Hand flapping or curling, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: Continuous duration recording <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: Continuous access and, dense and lean schedules of noncontingent access <i>Dosage</i>: 3 days per week, 3-7 sessions per day, 5 mins per session <i>Agent</i>: Experimenter	Continuous access to items was more effective in decreasing stereotypic behaviours than dense or lean schedules of noncontingent access. It was also preferred by participants and their parents.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Lory & Rispoli (2020)	<i>N</i> = 2 (2 males) <i>Ages</i> : 5 to 7 (<i>M</i> = 6:0) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Repetitive scripted vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : RIRD <i>Dosage</i> : either 5 mins or 20 mins per session <i>Agent</i> : Experimenter	Both 5-minute and 20-minute RIRD sessions effectively reduced vocal stereotypic behaviours.	Weak
Mariam Minazir & Kavitha (2016)	<i>N</i> = 14 (11 males; 3 females) <i>Ages</i> : 4 to 9 (mean age unknown) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor stereotypy <i>Topography</i> : Not specified <i>Intervention assessment</i> : Indirect observation <i>Measurement tool</i> : RBQ-2 scale <i>FA</i> : Not conducted	<i>Strategy</i> : DR <i>Dosage</i> : 3 sessions per week (overall 8 weeks) <i>Agent</i> : Experimenter	DR was effective in reducing stereotypic behaviours.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Marzouki et al. (2022)	N=22 (20 males; 2 females) Ages: 6 to 7 (M = 6:4) Diagnosis: ASD Ethnicity: Unknown	<i>Identification:</i> Not reported <i>Measurement tool:</i> Not reported <i>Dependent variable:</i> Motor and vocal stereotypy <i>Topography:</i> Not specified <i>Intervention assessment:</i> Indirect observation <i>Measurement tool:</i> GARS-2 <i>FA:</i> Not conducted	<i>Strategy:</i> technical aquatic training and play-based aquatic training <i>Dosage:</i> 2 sessions per week (overall 8 weeks), 50 mins per session <i>Agent:</i> Experimenter	Stereotypy scores in both aquatic intervention groups decreased significantly compared to the control group.	Strong
McNamara & Cividini-Motta (2019)	N = 3 (3 males) Ages: 8 to 11 (M = 9:4) Diagnosis: ASD Ethnicity: Unknown	<i>Identification:</i> Direct observation by caregivers <i>Measurement tool:</i> Not reported <i>Dependent variable:</i> Vocal stereotypy <i>Topography:</i> Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment:</i> Direct observation <i>Measurement type:</i> Continuous duration recording <i>FA:</i> Automatic reinforcement	<i>Strategy:</i> RIRD, response cost and RIRD+response cost <i>Dosage:</i> 5 mins per session <i>Agent:</i> Experimenter	RIRD, response cost and RIRD+response cost all effectively reduced stereotypic behaviours.	Adequate

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Moore et al. (2015) *	<i>n</i> = 2 (1 male; 1 female) <i>Ages</i>: 8 to 11 (<i>M</i> = 9:6) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Direct observation by clinical service and educational providers <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Nonfunctional hand, arm, or finger movement, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: Momentary time sampling (10s interval) <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: Sensory integration (sensory diets, brushing with deep-pressure therapy and the combination of both) <i>Dosage</i>: 3 days per week, 10 mins per session <i>Agent</i>: Trained teacher	None of the intervention strategies were effective in decreasing stereotypic behaviours.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Moradi et al. (2020)	<i>N</i> = 100 (100 males) <i>Ages</i>: 6 to 9 (<i>M</i> = 7:7) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Not specified <i>Intervention assessment</i>: Indirect observation <i>Measurement tool</i>: GARS-2 scale <i>FA</i>: Not conducted	<i>Strategy</i>: Perceptual-motor exercises, vitamin D3, and combination of both perceptual-motor exercises and vitamin D3 <i>Dosage</i>: 3 month, 1 hour per session for the perceptual-motor exercise condition <i>Agent</i>: Experimenter	Motor stereotypic behaviours decreased significantly across all three conditions. The combined perceptual-motor exercise and vitamin D3 condition was the most effective.	Strong
Neely et al. (2015)	<i>N</i> = 2 (1 male; 1 female) <i>Ages</i>: 7 to 8 (<i>M</i> = 7:6) <i>Diagnosis</i>: ASD, ID <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor stereotypy <i>Topography</i>: Body rocking, arm swinging, head touching <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 10s partial interval <i>FA</i>: At least in part by automatic reinforcement	<i>Strategy</i>: Antecedent-based intervention <i>Dosage</i>: 10-12 weeks overall, 2-3 days per week, once per day, 10 mins per session <i>Agent</i>: Experimenter	Exercise may be a potential treatment for stereotypy. It was most effective before the participants became satiated.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Nuzzolo & Walker (2024)	<i>N</i> = 3 (2 male; 1 female) <i>Ages</i>: 3 to 4 (<i>M</i> = 3:4) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Asian, Hispanic	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Tapping surfaces, spinning, body rocking, peripheral eye gazes, fingers and saliva playing, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 5s partial interval <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: Sensory integration therapy <i>Dosage</i>: 2-4 days per week, 10 mins per session <i>Agent</i>: Experimenter	Sensory integration therapy was not effective in reducing stereotypic behaviours.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Pokorski et al. (2019)	<i>N</i> = 1 (1 male) <i>Ages</i> : 6:6 <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Caucasian	<i>Identification</i> : Direct observation by parents and school teachers <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor and vocal stereotypy <i>Topography</i> : Self-hand pressing, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Momentary time sampling (5s interval) <i>FA</i> : Not conducted	<i>Strategy</i> : Antecedent-based interventions (gross motor activities, sensory based interventions, and seated work) <i>Dosage</i> : 3-4 days per week (overall 6 weeks), 1-2 sessions per day, 10-15 mins per session <i>Agent</i> : Teacher in the small group activity	Gross motor activities and seated work antecedent-based interventions were effective in reducing stereotypic behaviours. However, sensory-based antecedent interventions were not effective.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Préfontaine et al. (2019)	<i>N</i> = 11 (9 males; 2 females) <i>Ages</i>: 3 to 10 (<i>M</i> = 6:3) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Hand clapping, mouthing, TV playing and pausing, objects rubbing, pen caps throwing, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 10s partial interval <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: NCR and DR <i>Dosage</i>: 2-4 days per week, 1 session per day, 10 mins per session <i>Agent</i>: Trained experiment assistants	NCR reduced stereotypic behaviours for 5 out of 11 participants. DR reduced stereotypic behaviours for 3 out of 11 participants. Neither NCR nor DR was effective for 3 participants.	Adequate

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Rapp et al. (2017)	<i>N</i> = 4 (4 males) <i>Ages</i> : 3 to 7 (<i>M</i> = 4:9) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor and vocal stereotypy <i>Topography</i> : Noncontextual gross motor hand movements, hand flapping, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : NCR and DRO <i>Dosage</i> : 2-3 days per week, 3-4 sessions per day, at least 10 mins per session <i>Agent</i> : Experimenter	Preferred stimuli decreased the frequency of stereotypy. NCR and DRO reduced stereotypic behaviours for 3 participants.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Rosenzweig et al. (2024) *	<i>n</i> = 2 (1 male; 1 female) <i>Ages</i>: 2:0 <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Direct observation by clinical service provider <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Scratching or tapping surfaces, arm swinging, rubbing objects, hand flapping, turning back and forth in chair, sliding desk back and forth, opening/closing doors, finger posturing, flapping ears, twisting upper body, body rocking or tensing, headshaking, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: Continuous duration recording <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: Rotating Competing Stimuli and prompting functional engagement <i>Dosage</i>: 15-35 mins per day <i>Agent</i>: Experimenter	Prompting functional engagement effectively reduced stereotypic behaviours for both participants. Rotating competing stimuli were effective for one participant (male). However, they were less effective for the other participant (female).	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Saini et al. (2015)	<i>N</i> = 4 (4 males) <i>Ages</i> : 5 to 8 (<i>M</i> = 5:9) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Direct observation by caregivers <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor and vocal stereotypy <i>Topography</i> : Hand flapping, visual hand tracking, finger stretching, hyperextension, knocking, noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : 10s partial interval <i>FA</i> : Not conducted	<i>Strategy</i> : Traditional RIRD and variation of RIRD <i>Dosage</i> : 5 mins per session <i>Agent</i> : Experimenter	Traditional and variation of RIRD both effectively reduced the frequency of stereotypic behaviours for all participants. However, variation of RIRD was more efficient (less implementation time while maintaining effectiveness).	Adequate

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Scalzo et al. (2015)	<i>N</i> = 1 (1 male) <i>Ages</i> : 12:0 <i>Diagnosis</i> : ASD, ID <i>Ethnicity</i> : Caucasian	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : 10s partial interval <i>FA</i> : Automatic reinforcement, escape	<i>Strategy</i> : Music NCR, DRO, self-recording, and FCT <i>Dosage</i> : 2 times per week <i>Agent</i> : Experimenter	Only FCT effectively reduced the stereotypic behaviours. However, participants in the FCT condition received approximately twice as many intervention sessions as those in other conditions.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Sivaraman & Rapp (2020)	<i>N</i> = 2 (2 males) <i>Ages</i> : 5 to 7 (<i>M</i> = 6:0) <i>Ethnicity</i> : <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Not conducted	<i>Strategy</i> : RIRD <i>Dosage</i> : 3 days per week, 20-35 mins per session <i>Agent</i> : Experimenter	Both 5-minute and 20-minute RIRD sessions reduced the frequency of vocal stereotypy.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Shawler et al. (2020)	<i>N</i> = 2 (1 male; 1 female) <i>Ages</i>: 5 to 7 (<i>M</i> = 6:0) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Direct observation by caregivers and school teachers <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Vocal stereotypy <i>Topography</i>: Noncontextual or nonfunctional repetitive vocalisations, echolalia <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 5s partial interval <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: RIRD, competing stimuli and non-competing stimuli <i>Dosage</i>: 5 mins per session <i>Agent</i>: Experimenter	Both RIRD and competing stimuli reduced vocal stereotypy (competing stimuli were more efficient). Non-competing stimuli were not effective.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Shawler & Miguel (2015)	<i>N</i> = 5 (4 males; 1 female) <i>Ages</i>: 5 to 12 (<i>M</i> = 8:5) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Vocal stereotypy <i>Topography</i>: Noncontextual or nonfunctional repetitive vocalisations, echolalia <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: Continuous duration recording <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: RIRD <i>Dosage</i>: 2-4 days per week, 2-5 sessions per day, session range from 5-50 mins <i>Agent</i>: Experimenter	Most participants (4 out of 5) showed reduced vocal stereotypy with both vocal and motor RIRD. Neither intervention was effective for one participant.	Adequate

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Slaton & Hanley (2016) *	<i>n</i> = 1 (1 male) <i>Ages</i> : 11:0 <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Direct observation by school teachers <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor stereotypy <i>Topography</i> : knocking, tapping, clapping, waving hands in front of face, wringing hands, raising and lowering arms, shaking arms, kicking, shaking head from side to side, tilting head back and forth while squinting, body rocking, bouncing, and jumping <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous event recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : Chained schedule and multiple schedule <i>Dosage</i> : 3-5 days per week, 2-6 sessions per day <i>Agent</i> : Experimenter	Both chained and multiple schedules were effective in reducing stereotypic behaviours. The chained schedule was more effective.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Sloman et al. (2022) *	<i>n</i> = 1 (1 female) Ages: 12:0 Diagnosis: ASD Ethnicity: Unknown	<i>Identification</i> : Direct observation by school teachers <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : Chained schedules with RIRD and multiple schedules with RIRD, chained schedule without RIRD, and mixed schedule with RIRD <i>Dosage</i> : 6 mins per session <i>Agent</i> : Trained teaching assistant	Chained schedule with RIRD, multiple schedule with RIRD, and mixed schedule with RIRD were effective in reducing stereotypic behaviours. Chained schedules without RIRD produced only slight reductions and stereotypic behaviours remained above criterion levels.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Sniezyk & Zane (2015)	<i>N</i> = 3 (2 males; 1 female) <i>Ages</i>: 2:9 to 3:5 (<i>M</i> = 3:0) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Direct observation by school teachers <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor stereotypy <i>Topography</i>: Noncontextual or nonfunctional repetitive movements of the body or specific body parts <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 10s partial interval <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: Sensory integration <i>Dosage</i>: 0-2.5 hours per day <i>Agent</i>: Trained teacher	Sensory integration therapy was not effective in reducing stereotypic behaviours.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Tabeshian et al. (2022)	<i>N</i> = 23 (19 males; 4 female) <i>Ages</i> : 6 to 12 (<i>M</i> = 9:7) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Motor and vocal stereotypy <i>Topography</i> : Not specified <i>Intervention assessment</i> : Indirect observation <i>Measurement tool</i> : GARS-2 scale <i>FA</i> : Not conducted	<i>Strategy</i> : Tai Chi training <i>Dosage</i> : 3 days per week (overall 12 weeks), 1 session per day, 45 mins per session <i>Agent</i> : Experimenter	Stereotypy scores in the experimental group decreased significantly following Tai Chi training compared to the control group. This effect was maintained at the 1-month follow-up.	Weak
Thomas et al. (2020) *	<i>n</i> = 3 (3 males) <i>Ages</i> : 9 to 11 (<i>M</i> = 10:4) <i>Diagnosis</i> : ASD <i>Ethnicity</i> : Asian	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i> : Direct observation <i>Measurement type</i> : 10s partial interval <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : Noncontingent access to a competing stimulus <i>Dosage</i> : 1 session per day, 20 mins per session <i>Agent</i> : Experimenter	Noncontingent access to a competing stimulus (singing) effectively reduced vocal stereotypy.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Toper-Korkmaz et al. (2018)	<i>N</i> = 3 (1 male; 2 females) <i>Ages</i>: 4 to 6 (<i>M</i> = 5:4) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Vocal stereotypy <i>Topography</i>: Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: 10s partial interval <i>FA</i>: Automatic reinforcement	<i>Strategy</i>: Traditional RIRD and variation RIRD <i>Dosage</i>: 1 or 2day per week, 5 mins per session <i>Agent</i>: Experimenter	Traditional and variation of RIRD both effectively reduced stereotypic behaviours. However, variation of RIRD was more efficient (less implementation time while maintaining effectiveness).	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Trudel et al. (2021)	<i>N</i> = 7 (6 male; 1 unknown) <i>Ages</i>: 2 to 9 (<i>M</i> = 5:3) <i>Diagnosis</i>: ASD <i>Ethnicity</i>: Unknown	<i>Identification</i>: Not reported <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor and vocal stereotypy <i>Topography</i>: Body rocking, mouthing, pacing and jumping, Noncontextual or nonfunctional repetitive vocalisations <i>Intervention assessment</i>: Direct observation <i>Measurement type</i>: Continuous duration recording <i>FA</i>: Not conducted	<i>Strategy</i>: DRA and NCR <i>Dosage</i>: Unknown <i>Agent</i>: Trained parents	Parent-implemented DRA and NCR effectively reduced stereotypic behaviours for 6 out of 7 participants.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Tse et al. (2018)	<i>N</i> = 30 (22 males; 8 females) <i>Ages</i>: 9 to 12 (<i>M</i> = 10:2) <i>Diagnosis</i>: ASD, ID <i>Ethnicity</i>: Unknown	<i>Identification</i>: Direct observation by physician <i>Measurement tool</i>: Not reported <i>Dependent variable</i>: Motor stereotypy <i>Topography</i>: Hand flapping, body rocking <i>Intervention Assessment</i>: Direct observation and indirect assessment (supplementary) <i>Measurement type</i>: Continuous event recording and GARS-3 (supplementary) <i>FA</i>: Not conducted	Strategy: Antecedent-based intervention (ball-tapping-exercise) Dosage: 2 sessions per week (overall 12 weeks), 20 mins per session Agent: Experimenter	The intervention produced partial effects: hand-flapping decreased whereas body-rocking did not.	Weak

Study	Participant Characteristics	Assessments of Stereotypies	Intervention Strategies, Dosage, and Agent	Results	Strength rating
Wunderlich & Vollmer (2015) *	<i>n</i> = 5 (1 male; 4 females) <i>Ages</i> : 4 to 12 (<i>M</i> = 7:7) <i>Diagnosis</i> : ASD, ID, Trisomy 9 <i>Ethnicity</i> : Unknown	<i>Identification</i> : Not reported <i>Measurement tool</i> : Not reported <i>Dependent variable</i> : Vocal stereotypy <i>Topography</i> : Noncontextual or nonfunctional repetitive vocalisations <i>Intervention Assessment</i> : Direct observation <i>Measurement type</i> : Continuous duration recording <i>FA</i> : Automatic reinforcement	<i>Strategy</i> : Motor RIRD and vocal RIRD <i>Dosage</i> : 2-5 days per week, 2-6 sessions per day, last than 5 mins per session <i>Agent</i> : Experimenter	Both motor and vocal RIRD effectively reduced vocal stereotypy outside intervention sessions. However, only two participants showed consistently lower rates of stereotypic behaviours across all sessions.	Weak

Note. * indicated that more participants were included in the paper than listed. However, those participants did not meet the inclusion criteria and therefore they were not listed or discussed on the table. Ages expressed as years: months. Identification refers to how stereotypy was initially identified prior to participant referral. Measurement tool refers to the method used to assess stereotypy prior to participant referral. FA refers to the function of stereotypy as identified by functional analysis.

Interrater Reliability

The first rater extracted and reviewed data from all included studies (16 non-intervention-based and 49 intervention-based) and evaluated the aforementioned variables.

The second rater independently reviewed a randomly selected 30% of the studies (non-intervention-based studies, $n = 5$; intervention-based studies, $n = 15$) to assess interrater reliability. The initial agreement was 86.2 %. Disagreements were resolved through discussion until there was a consensus, thus reaching 100% agreement.

Following data extraction, the quality of the included papers was evaluated by both raters. The first rater evaluated all included papers ($n = 65$) whereas the second rater independently reviewed a randomly selected 30% of the studies ($n = 20$, including 5 non-intervention-based studies, 12 single case design intervention-based studies, and 3 group design intervention-based studies) to assess interrater reliability for quality evaluations. Initial agreement for quality evaluations across included studies was 85.7% (non-intervention-based agreement 84.2%; intervention-based agreement = 86.5%). Disagreements were resolved through discussion until consensus was reached at 100% agreement.

Results

Non-Intervention-Based Studies

Participant Characteristics

A total of 16 non-intervention-based studies were included in this systematic review,

including 4,378 children (3,619 males, 716 females and 43 gender unspecified) between the age of 1 and 24. Most participants had a formal ASD diagnosis (99.2%, $n = 4,343$) while a small number were typically developing children (0.8%, $n = 35$). Only Brierley et al. (2021) reported the participants' ethnicity, although more than half of their participants' ethnicity information was not available.

Assessments of Stereotypies

Approximately half of the included studies (43.8%, $n = 7$) used direct observational methods to quantify stereotypy whereas the remaining studies used indirect observation (56.2%, $n = 9$). The most commonly used measurement types for direct observation were continuous event recording (42.8%, $n = 3$), followed by continuous duration recording (14.2%, $n = 1$) and video-based observation (14.2%, $n = 1$). One study (14.2%) did not clearly specify the measurement type used to assess stereotypy. Another study (14.2%, $n = 1$) did not use an applied behaviour analytic approach but rather, employed kinematic measurement. All direct assessments were conducted by experimenters. For indirect observation, the most frequently used assessment tool was the Repetitive Behavior Scale-Revised (RBS-R; Bodfish et al., 2000) (33.3%, $n = 3$), followed by the Aberrant Behavior Checklist (ABC; Aman et al., 1985) (22.2%, $n = 2$). All indirect assessment tools were completed by parents or caregivers.

Types of Stereotypies

The majority of studies measured both motor and vocal stereotypy (56.3%, $n = 9$). Five studies (31.3%) measured motor stereotypy alone and two studies (12.5%) measured vocal stereotypy alone.

Numerous different topographies were measured across the studies. Most direct observation studies (83.3%, $n = 5$) measured multiple topographies, whereas one study (16.6%, $n = 1$) measured only a single topography of stereotypy. All indirect observation studies ($n = 6$) did not specify the topography of stereotypy that was measured. Body rocking and head movements were the most commonly measured motor stereotypy (18.7%, $n = 3$), followed by hand or arm flapping (12.5%, $n = 2$). In contrast, the most commonly measured vocal stereotypy topography was noncontextual or nonfunctional repetitive vocalisations (25%, $n = 4$), followed by echolalia (18.7%, $n = 3$).

Findings

The research topics among these studies were diverse. Therefore, few findings have been replicated. However, at least two studies found that intelligence quotient (IQ) was negatively correlated with the frequency of stereotypy behaviours. Additionally, sensory impairment was also found to be negatively correlated with stereotypic behaviours. Interestingly, mixed findings were reported regarding the association between gender and stereotypy. Jasim and Perry (2023) did not find significant gender differences using the Repetitive Behavior Scale-Revised (Bodfish et al., 2000) whereas Stephenson et al. (2023)

reported that males scored higher on stereotypy scales using Autism Spectrum Rating Scales (Goldstein & Naglieri, 2009).

Strength Rating

The quality of the studies using the standard described by the Appraisal Tool for Cross-Sectional Studies (Downes et al., 2016) were generally met most of the assessment criteria. More details about the quality evaluation of non-intervention-based studies can be found in Table 3.

Intervention-Based Studies

Participant Characteristics

A total of 49 intervention-based studies (including 44 single case design studies and 5 group design studies) were included in this systematic review, including 308 children under the age of 12 (ranging from 2 to 12) with a formal ASD diagnosis who received intervention. A few studies also reported a secondary diagnosis in addition to ASD (16.3%, $n = 8$). The majority of the participants were male (85.3%, $n = 263$) while a small proportion were female (14.2%, $n = 44$) and gender was unknown for one participant (0.3%, $n = 1$). The majority of studies did not report participant ethnicity. Only seven studies reported participants' ethnicity. Among the participants for whom ethnicity was specified, seven were Caucasian (2.3%), two were Asian (0.6%), and two were Hispanic (0.6%).

Table 3*Summary of Quality Assessment on Non-Intervention-Based Studies*

Quality Indicators	Brierley et al. (2021) **	Feta et al. (2021) **	Gladfelter & VanZuiden (2020)	Grossi et al. (2021)	Gundogdu et al. (2023)	Jasim & Perry (2023) **	Kelly & Reed (2021)	Lanzarini et al. (2021)
1. Clear aims & objectives	Y	Y	Y	Y	Y	Y	Y	Y
2. Appropriate study design	Y	Y	Y	Y	Y	Y	Y	Y
3. Sample size justification	N	N	N	N	N	N	N	N
4. Population clearly defined	Y	Y	Y	Y	Y	Y	Y	Y
5. Appropriate sample frame	Y	Y	Y	Y	Y	Y	Y	Y
6. Representative selection process	Y	Y	Y	Y	Y	Y	Y	Y
7. Categorisation of non-responders	Y	N	N	N	Y	Y	N	N
8. Variables appropriate to the aim	Y	Y	Y	Y	Y	Y	Y	Y
9. Validated measures used	Y	Y	Y	Y	Y	Y	Y	Y
10. Clear reporting of statistical significance	Y	Y	Y	Y	Y	Y	Y	Y
11. Methods described for replication	P	P	Y	Y	Y	Y	Y	Y
12. Descriptive statistics reported	Y	Y	Y	Y	Y	Y	Y	Y
14. Detail of any non-responding	Y	N	N	N	Y	P	N	N
15. Internal consistency of results	Y	Y	Y	Y	Y	Y	Y	Y
16. Analysis as described in method	Y	Y	Y	Y	Y	Y	Y	Y
17. Justification of discussion and conclusion	Y	Y	P	Y	P	Y	P	Y
18. Limitations discussed	Y	Y	Y	Y	Y	Y	Y	Y
19. Any funding or conflict of interest	NC	N	N	NC	N	N	NC	N
20. Ethical approval or consent obtained	N	Y	Y	Y	Y	Y	Y	Y

Quality Indicators	Lydon et al. (2015) *	Reda et al. (2021)	Reis et al. (2023)	Sannar et al. (2018) **	Stephens on et al. (2023)	Termine et al. (2021) **	Zhao et al. (2021) **	Wunderlich et al. (2020) *
1. Clear aims & objectives	Y	Y	Y	Y	Y	Y	Y	Y
2. Appropriate study design	Y	Y	Y	Y	Y	Y	Y	Y
3. Sample size justification	N	N	N	N	N	N	N	N
4. Population clearly defined	N	Y	Y	Y	Y	Y	Y	N
5. Appropriate sample frame	N	Y	Y	Y	Y	Y	Y	N
6. Representative selection process	P	Y	Y	Y	Y	Y	Y	P
7. Categorisation of non-responders	N	N	N	N	N	N	N	N
8. Variables appropriate to the aim	Y	Y	Y	Y	Y	Y	Y	Y
9. Validated measures used	Y	Y	Y	Y	Y	Y	Y	Y
10. Clear reporting of statistical significance	Y	Y	Y	Y	Y	P	Y	N
11. Methods described for replication	P	Y	Y	Y	Y	Y	Y	Y
12. Descriptive statistics reported	Y	Y	Y	Y	Y	Y	Y	Y
14. Detail of any non-responding	N	N	N	N	N	N	N	N
15. Internal consistency of results	Y	Y	Y	Y	Y	Y	Y	Y
16. Analysis as described in method	P	Y	Y	Y	Y	Y	Y	Y
17. Justification of discussion and conclusion	Y	P	P	P	Y	Y	Y	Y
18. Limitations discussed	Y	P	Y	P	Y	Y	Y	P
19. Any funding or conflict of interest	N	N	N	N	NC	N	NC	NC
20. Ethical approval or consent obtained	N	Y	Y	Y	N	Y	Y	N

Note. * Indicates that more participants were included in the paper than listed. However, those participants did not meet the inclusion criteria and therefore they were not listed or discussed on the table. ** Indicates that results for children under 12 were not disaggregated from the overall group and therefore include data from participants over 12. Codes for quality rating indicators are as follows: Y = yes; N = no; P = partial; NC = not clear. Item 13: Concern for non-response bias was not included.

Assessments of Stereotypies

Less than half of the studies reported how stereotypy was initially identified prior to participant referral (40.2%, $n = 20$). Of the studies that reported this information, stereotypy was most commonly initially reported by parents or caregivers (35%, $n = 7$), followed by clinical service provider (25%, $n = 5$), school teachers (20%, $n = 4$), both school teachers and caregivers (15%, $n = 3$), and physician (5%, $n = 1$). Of the studies that reported how stereotypy was initially screened, only Edwards et al. (2018) specified the use of a standardised measure (Behavior Problems Inventory [BPI]; Rojahn et al., 2001) to assess stereotypy prior to participant referral. The remaining studies did not report how stereotypy was measured after participants were identified as exhibiting severe stereotypic behaviour warranting intervention.

More than half of the studies (65.3%, $n = 32$) conducted a functional analysis and the identified function for stereotypy was automatic reinforcement. One study (2%) reported that the identified function for stereotypy was a mixture of multiple functions. Another (2%) reported that stereotypy was identified as at least partly automatic reinforcement and further research required to rule out other functions. Seventeen of the studies did not conduct a functional analysis, report or identify the function of stereotypy prior to the intervention (34.6%, $n = 17$).

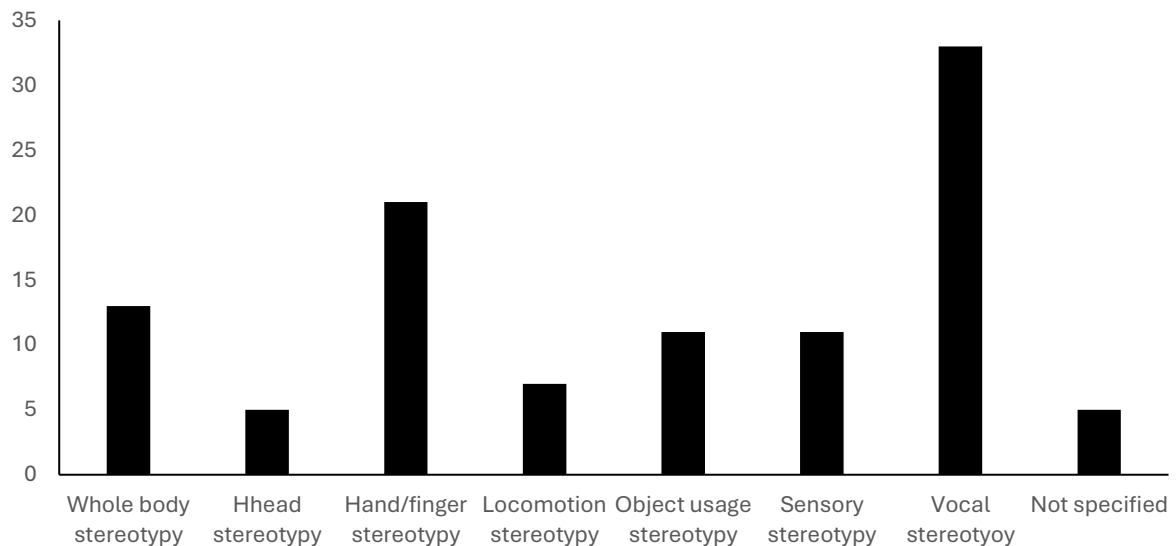
Approximately one-third of the studies measured motor stereotypy (38.7%, $n = 19$) and

13 studies measured vocal stereotypy (26.5%). Seventeen of the studies (34.6%) measured both motor and vocal stereotypy.

Numerous different topographies were measured across the studies. Approximately one-third (34.7%, $n = 17$) of the studies measured only a single topography of stereotypy. Six studies (12.2%) did not specify the topography of stereotypy that was measured (including direct and indirect observation). The remaining studies (48.9%, $n = 24$) measured multiple topographies. Topographies of stereotypy were categorised following Akers et al. (2020) as whole body stereotypy (e.g., body rocking), head stereotypy (e.g., head shaking), hand or finger stereotypy (e.g., hand flapping), locomotion stereotypy (e.g., pacing), object usage stereotypy (e.g., objects rotating), and sensory stereotypy (e.g., saliva playing). More details are presented in Figure 2. When it comes to more specific topographies, hand flapping was the most commonly measured motor stereotypy (28.6%, $n = 14$), followed by body rocking (18.4%, $n = 9$) and tapping of hands or objects (16.3%, $n = 8$). In contrast, the most commonly measured vocal stereotypy topography was noncontextual or nonfunctional repetitive vocalisations (55.1%, $n = 27$), followed by echolalia (8.2%, $n = 4$).

Figure 2

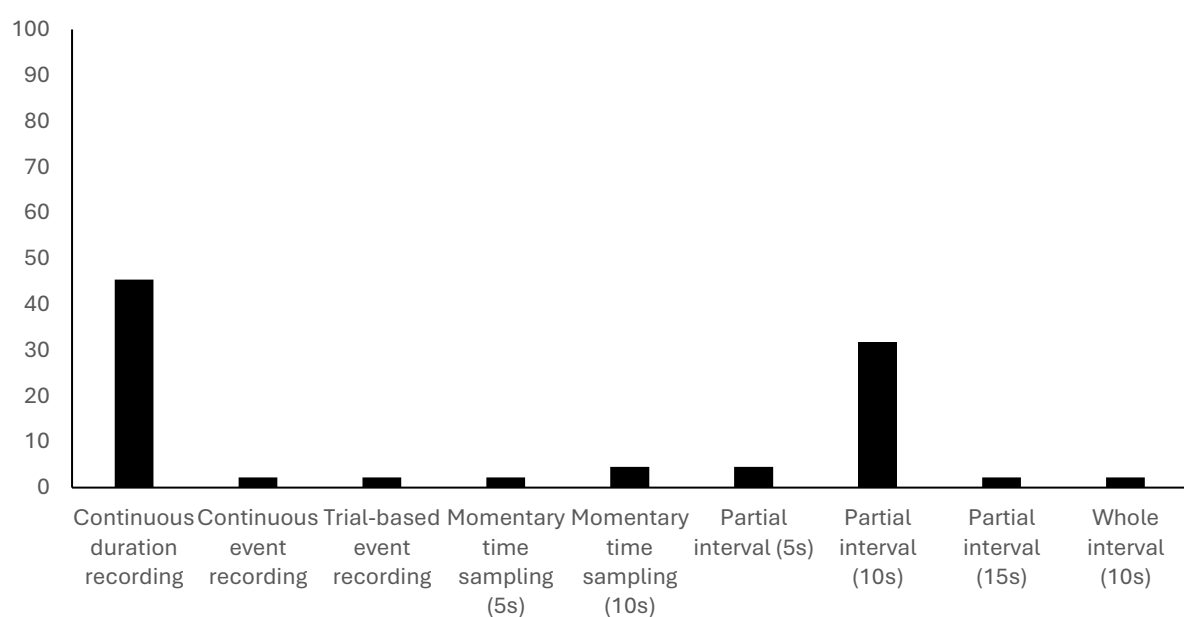
Summary of Topographies Measured in Intervention-Based Single Case Design Studies



Note. The x-axis represents the topographies of stereotypy. The y-axis represents the number of studies that measured at least one instance of the corresponding topography. Studies that measured multiple topographies of stereotypy were included in each corresponding topography category. Therefore, the sum of the bars may exceed the total number of studies.

Figure 3

Measurement Types Used in Intervention-Based Single Case Design Studies

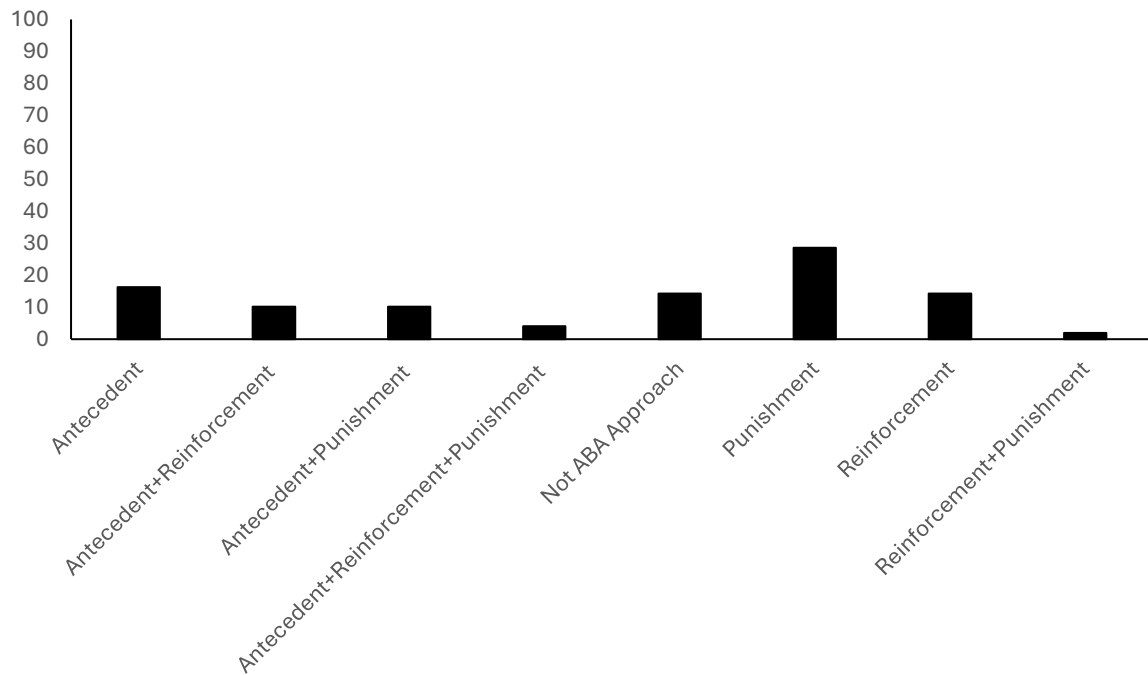


Note. The x-axis represents the measurement type. The y-axis represents the percentage of studies.

During intervention and outcome evaluation, all single case design studies (100%, $n = 44$) used direct observational methods to measure stereotypy as the dependent variable. The measurement types included continuous duration recording (45.5%, $n = 20$), continuous event recording (2.3%, $n = 1$), trial-based event recording (2.3%, $n = 1$), momentary time sampling (5s: 2.3 %, $n = 1$; 10s: 4.5%, $n = 2$), partial interval (5s: 6.8 %, $n = 3$; 10s: 31.8%, $n = 14$; 15s: 2.3%, $n = 1$), and whole interval (10s: 2.3%, $n = 1$). More details are presented in Figure 3. In contrast, most group design studies (80%, $n = 4$) used only indirect observation to compare pre- and post-intervention stereotypy scores. One group design study (20%) used indirect assessment pre- and post-intervention as a supplementary measure of overall stereotypy severity and during the intervention whereas direct assessment (continuous event recording) was used to measure stereotypy. The most frequently used indirect assessment tool was Gilliam Autism Rating Scale-Second Edition (GARS-2; Gilliam, 2006) (60%, $n = 3$), followed by Gilliam Autism Rating Scale-Third Edition (GARS-3; Gilliam, 2013) (20%, $n = 1$), and Repetitive Behavior Questionnaire-2 (RBQ-2; Leekam et al., 2007) (20%, $n = 1$).

Figure 4

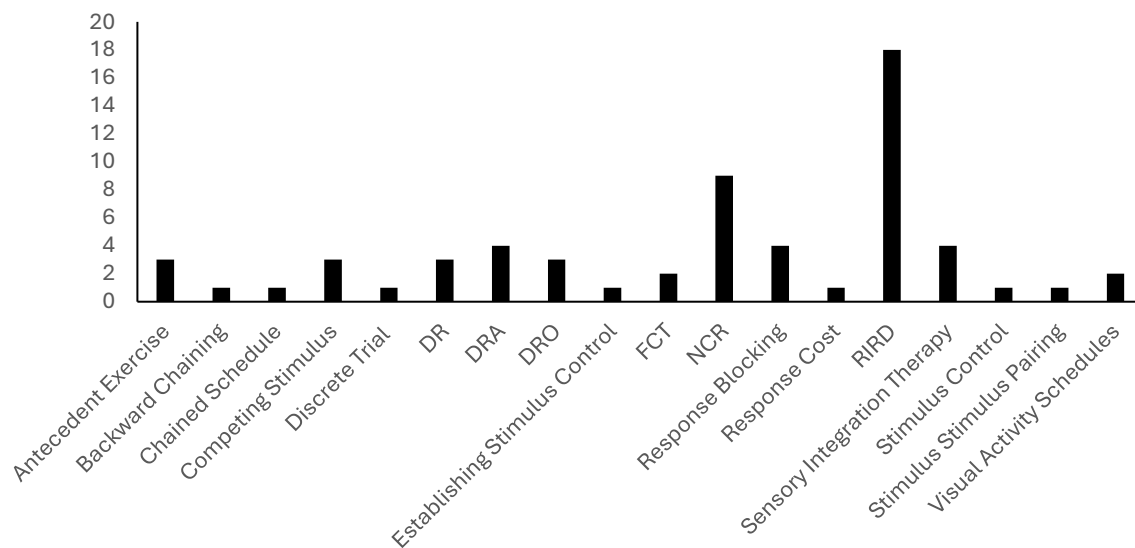
Intervention Types Used in Intervention-Based Single Case Design Studies



Note. The x-axis represents the intervention type. The y-axis represents the percentage of studies.

Figure 5

Intervention Specific Procedures Used in Intervention-Based Single Case Design Studies



Note. The x-axis represents the procedures. The y-axis represents the number of studies.

Studies that used multiple procedures were included in each corresponding procedure category. Therefore, the sum of the bars may exceed the total number of studies.

Intervention Assessment

Intervention strategies vary across studies, interventions were categorised following Akers et al. (2020) as antecedent intervention, combination of antecedent and reinforcement-based intervention, combination of antecedent and punishment-based intervention, combination of antecedent, reinforcement and punishment-based intervention, not applied behaviour analysis (ABA) approach, reinforcement-based intervention, punishment-based intervention, and combination of reinforcement and punishment-based intervention. Further details are presented in Figure 4. These procedures included response interruption and redirection (RIRD), functional communication training (FCT), noncontingent reinforcement (NCR), discrete trial, chain schedule (e.g., backward chaining, concurrent chain schedules), differential reinforcement (e.g., differential reinforcement of alternative behaviour or differential reinforcement of other behaviour), completing stimulus, antecedent-based intervention, sensory integration and physical activities. RIRD was the most widely used intervention, applied in 36.7% ($n = 18$) of the included studies. Differential reinforcement was the second most common intervention, used in 10 studies (20.4%) as at least one of the intervention strategies. More details are presented in Figure 5.

Most of the intervention strategies were effective in reducing stereotypic behaviours.

However, sensory integration was the only intervention strategy that was not effective for the reduction of stereotypic behaviours. These intervention strategies were mostly conducted by the researchers (85.7%, $n = 42$). A few of the interventions were conducted by the trained teachers (10.2%, $n = 5$) or parents (4.1%, $n = 2$). Dosage also varied across studies with duration ranging from intensive intervention (5 times per week) to lean intervention (1 to 2 times per week).

Strength Rating

The quality of the studies using the standard described by Reichow et al. (2011) were generally weak across the included studies (79.6%, $n = 39$). A few of the studies were rated as strong (6.1%, $n = 3$) or adequate (10.2%, $n = 5$). Across the primary quality indicators, most studies were coded as H (high) rating for the dependent variable (85.7%, $n = 42$, including 4 group design studies and 38 single case design studies). In contrast, few single case design studies were coded as H (high) rating for the baseline condition (20.5%, $n = 9$). For the secondary quality indicators, most single case design studies reported interobserver agreement (95.4%, $n = 42$) whereas most group design studies reported social validity (80%, $n = 4$). Notably, less than one-third of the single case design studies reported maintenance or generalisation (27.3%, $n = 12$). More details about the quality evaluation of intervention-based studies can be found in Table 4 (single case design) and Table 5 (group design).

Table 4

Summary of Quality Assessment on Intervention-Based Studies (Single Case Design) Met the Inclusion Criteria

Primary Quality Indicators							Secondary Quality Indicators					
Study	PART	IV	BSLN	DV	VIS ANAL	EXP CON	IOA	KAP	BR	FID	G/M	SV
Barszcz et al. (2021)	A	H	U	H	H	A	P	N	N	N	N	N
Boyle et al. (2018)	A	A	H	H	H	A	P	N	N	N	N	N
Callahan et al. (2023)	A	H	U	H	A	A	P	N	N	P	P	N
Cariveau et al. (2016)	A	H	H	H	H	H	P	N	N	P	P	N
Cividini-Motta et al. (2019) *	A	H	U	H	A	A	P	N	N	N	N	N
Cook & Rapp (2020)	A	H	A	H	A	A	P	N	N	N	N	N
DeRosa et al. (2019) *	A	H	A	H	A	A	P	N	N	N	N	N

Primary Quality Indicators							Secondary Quality Indicators					
Study	PART	IV	BSLN	DV	VIS ANAL	EXP CON	IOA	KAP	BR	FID	G/M	SV
Edwards et al. (2018)	H	H	H	H	A	A	P	N	N	P	N	N
Esposito et al. (2021)	A	A	U	A	H	H	N	N	N	N	P	N
Esposito et al. (2021)	H	A	H	H	H	H	P	N	N	P	P	N
Falligant & Dommestru p (2020)	A	H	U	H	A	A	P	N	N	P	P	P
Gauthier et al. (2020) *	A	H	A	H	A	H	P	N	N	P	N	N
Gehrman et al. (2017)	A	H	A	H	H	A	P	N	N	P	N	N
Gerow et al. (2019)	A	H	A	H	U	A	P	N	N	P	N	P
Gibbs et al. (2018)	A	H	U	H	A	H	P	N	N	P	P	N
Gibney et al. (2020) *	A	H	A	H	A	H	P	N	N	P	P	P

Primary Quality Indicators							Secondary Quality Indicators					
Study	PART	IV	BSLN	DV	VIS ANAL	EXP CON	IOA	KAP	BR	FID	G/M	SV
Goldman et al. (2021)	A	A	U	H	U	A	P	N	N	N	N	P
Greenberg et al. (2016)	A	H	H	A	A	H	P	N	N	N	P	P
Labrèche & Lanovaz (2019)	U	A	U	A	U	U	N	N	P	N	N	N
LaFrance et al. (2015)	A	A	A	H	U	A	P	N	N	N	N	N
Ledbetter-Cho et al. (2017)	H	H	H	H	H	H	P	N	N	P	P	P
Ledbetter-Cho et al. (2023) *	H	H	A	A	A	H	P	N	N	P	P	P
Llinas et al. (2022)	A	H	A	H	A	A	P	N	N	P	N	P

Primary Quality Indicators							Secondary Quality Indicators					
Study	PART	IV	BSLN	DV	VIS ANAL	EXP CON	IOA	KAP	BR	FID	G/M	SV
Lory & Rispoli (2020)	A	H	U	H	U	U	P	N	N	N	N	N
McNamara & Cividini-Motta (2019)	A	H	A	H	H	H	P	N	N	P	N	P
Moore et al. (2015) *	A	A	A	H	U	A	P	N	N	N	N	N
Neely et al. (2015)	A	H	H	H	A	A	P	N	N	P	N	N
Nuzzolo & Walker (2024)	H	A	H	A	U	H	P	N	N	P	N	N
Pokorski et al. (2019)	H	H	U	H	U	U	P	N	N	P	N	N
Préfontaine et al. (2019)	H	H	A	H	A	H	P	N	N	N	N	N

Primary Quality Indicators							Secondary Quality Indicators					
Study	PART	IV	BSLN	DV	VIS ANAL	EXP CON	IOA	KAP	BR	FID	G/M	SV
Rapp et al. (2017)	A	A	U	H	A	H	P	N	N	N	N	N
Rosenzweig et al. (2024) *	A	H	U	H	A	H	P	N	N	N	N	N
Saini et al. (2015)	A	H	A	H	H	H	P	N	N	P	N	N
Scalzo et al. (2015)	A	A	U	H	U	A	P	N	N	N	N	N
Sivaraman & Rapp (2020)	A	H	H	H	A	H	P	N	N	N	N	N
Shawler et al. (2020)	A	H	A	H	A	H	P	N	N	P	P	P
Shawler & Miguel (2015)	A	H	A	H	H	H	P	N	N	P	P	P
Slaton & Hanley (2016) *	A	H	A	H	H	A	P	N	N	N	N	N

Primary Quality Indicators							Secondary Quality Indicators					
Study	PART	IV	BSLN	DV	VIS ANAL	EXP CON	IOA	KAP	BR	FID	G/M	SV
Sloman et al. (2022) *	A	H	A	H	H	A	P	N	N	P	N	N
Snieszky & Zane (2015)	A	H	A	H	U	U	P	N	N	P	N	N
Thomas et al. (2020) *	H	H	A	H	U	H	P	N	N	P	N	N
Toper-Korkmaz et al. (2018)	A	H	A	H	A	A	P	N	N	P	N	N
Trudel et al. (2021)	U	H	A	A	H	H	P	N	N	N	N	P
Wunderlich & Vollmer (2015) *	A	H	A	H	A	H	P	N	N	N	N	N

Note. Primary quality indicators were rated as high (H), acceptable (A), or unacceptable (U). PART refers to participant characteristic. IV refers to independent variable. BSLN refers to baseline condition. DV refers to dependent variable. VIS ANAL refers to visual analysis. EXP CON refers to experimental condition. Secondary quality indicators were rated on a dichotomous scale and rated as either positive (P) or negative (N).

IOA refers to interobserver agreement. KAP refers to Kappa. BR refers to blind raters. FID refers to fidelity. G/M refers to generalisation or maintenance. SV refers to social validity. * Indicated that more participants were included in the paper than listed. However, those participants did not meet the inclusion criteria and therefore they were not listed or discussed on the table.

Table 5

Summary of Quality Assessment on Intervention-Based Studies (Group Design) Met the Inclusion Criteria

Primary Quality Indicators							Secondary Quality Indicators							
Study	PART	IV	CC	DV	LRQ	STAT	RA	IOA	BR	FID	ATR	G/M	ES	SV
Mariam Minazir & Kavitha (2016)	U	U	U	U	H	A	N	N	N	N	N	N	N	N
Marzouki et al. (2022)	H	H	H	H	H	H	P	N	N	N	P	N	P	P
Moradi et al. (2020)	H	H	H	H	H	H	P	N	N	N	N	N	N	P
Tabeshian et al. (2022)	A	U	H	H	H	H	P	N	N	N	N	P	N	P
Tse et al. (2018)	H	A	U	H	H	H	N	P	N	N	N	N	N	P

Note. Primary quality indicators were rated as high (H), acceptable (A), or unacceptable (U). PART refers to participant characteristic. IV refers to independent variable. CC refers to comparison condition. DV refers to dependent variable. LRQ refers to Link between research question and

data analysis. STAT refers to Statistical analysis. Secondary quality indicators were rated on a dichotomous scale and rated as either positive (P) or negative (N). RA refers to random assignment. IOA refers to interobserver agreement. BR refers to blind raters. FID refers to fidelity. ATR refers to attrition. G/M refers to generalisation or maintenance. ES refers to effect size. SV refers to social validity.

Discussion

The current review systematically evaluated the literature related to stereotypy published over the past 10 years. Included studies were evaluated across several key domains and their sub-components, including participant characteristics (number of participants, age, gender, ethnicity, and diagnosis), assessment of stereotypy (how stereotypy was initially identified prior to participant referral, the method used to assess stereotypy prior to participant referral, assessment type, dependent variables, topography, measurement tools, and function as identified through functional analysis), intervention strategies (type of intervention, dosage, and implementers), main finding of the studies, and the quality of studies. Studies were evaluated on the quality and rigor using Reichow et al. (2011) and Appraisal Tool for Cross-Sectional Studies (Downes et al., 2016). To our knowledge, this is the first review to synthesise both intervention-based and non-intervention-based studies addressing motor and vocal stereotypy. Overall, 16 non-intervention-based papers and 49 intervention-based papers were included in this review. The main and secondary findings are discussed below.

Main Findings

Topography of Stereotypies

The most commonly measured topography of motor stereotypy across the included papers was hand movements-related stereotypy (e.g., hand flapping). Approximately one third of the included studies (3 group design studies and 21 single case design studies)

measured at least one form of hand or finger stereotypy. This pattern is consistent with a previous ASD stereotypic assessment and treatment review where hand movements-related stereotypy was the most commonly studied topography in research published between 1980 and 2010 (Reed et al., 2012). Similarly, a recent review on intervention to reduce motor stereotypy also reported that hand movements-related stereotypy remained the most commonly targeted topography (Akers et al., 2020). Across those studies, approximately 60% of participants exhibited hand or finger movements.

One possible explanation for hand movements-related stereotypy being the most commonly studied motor stereotypy is that it may also be the most common topography exhibited by the ASD population. Previous research showed that among more than 1000 captured stereotypies recorded from approximately 300 autistic children and adolescents attended appointments at a child neurology clinic in 2013, hand or arm stereotypies were the most frequent topography of motor stereotypy (Melo et al., 2023). These hand or arm stereotypies were further categorised into 35 different morphologies with the most common topographies being hand flapping, tapping, and jumping. Therefore, the high prevalence of hand and arm stereotypies in autistic clinical populations may contribute to their frequent selection as research targets across the included papers.

Another possible reason is that these motor stereotypies may hinder or interfere with daily functioning in the autistic population. Previous studies have emphasised that their

participants were referred to the research due to engaging in hand stereotypies that interfered with learning opportunities (Esposito et al., 2021; Saini et al., 2015). Similarly, research has also reported a positive correlation between the severity of motor stereotypy and maladaptive behaviour (Powell et al., 2017). Thus, given the potential impact of stereotypy on hindering learning opportunities, autistic children may need their parents or caregivers to seek research-based interventions and specialised clinical support (Cook & Rapp, 2020). Therefore, beyond high prevalence of hand movements-related stereotypy, the disruptive nature of these motor stereotypies may also explain why they are the most commonly addressed in both research and clinical settings.

Assessment of Stereotypies

Only 20 intervention-based studies reported how stereotypy was initially identified prior to participant referral. Among these papers, only Edwards et al. (2018) formally quantified stereotypies using a structured assessment before referral. These findings suggest that the majority of studies may rely on informal or non-professional observations prior to referral. Given that stereotypy is not exclusive to ASD and can also be observed in conditions such as obsessive-compulsive disorder or even in typically developing children (Harris et al., 2008), such behaviours may be misinterpreted. Previous research suggests that parents may interpret their children's engagement in RRBIs as a sign of ASD whereas these behaviours may instead be more closely aligned with obsessive-compulsive disorder (Santore et al., 2020). Therefore,

referrals based solely on informal observations by non-professionals (e.g., parents or school teachers) are concerning.

Another reason this is concerning is the discrepancy between professional and non-professional ratings of ASD symptoms. A previous study compared independent ratings on the *Checklist for Autism Spectrum Disorder* (CASD; Mayes, 2012) across more than a hundred autistic children completed by a psychologist, mothers, and teachers (Mayes & Lockridge, 2018) found substantial under-identification by non-professionals. Mothers failed to identify 36% of children and teachers even failed to identify 75% of the autistic children. These findings highlight the importance of standardised assessment procedures conducted by trained professionals as well as the need to develop clearer screening guidelines and structured procedures for non-professionals to accurately identify and quantify stereotypy prior to referral. This is particularly important given that accurate identification of target behaviours is a critical first step prior to assessing their function or implementing interventions for stereotypy.

Function of Stereotypies

When evaluating function of stereotypy, approximately 65% of the included studies conducted a functional analysis to identify the function of motor and vocal stereotypies. The vast majority of these studies reported that the function of the stereotypy was automatic reinforcement. The only two exceptions were Scalzo et al. (2015) who reported the function

was a mixture of automatic reinforcement and escape, and Neely et al. (2015) who reported that the stereotypy was at least partly maintained by automatic reinforcement but that other functions could not be ruled out without further testing. These results were consistent with previous review in which 93% of the included papers reported that the function of motor stereotypy was identified as automatic reinforcement (Akers et al., 2020). A similar pattern has also been found in vocal stereotypy where Mantzoros et al. (2022) conducted a meta-analytic review of treatments for automatic reinforced vocal stereotypy across 66 peer-reviewed papers.

Although research has consistently shown that stereotypy is often maintained by automatic reinforcement, the same stereotypic topography may be maintained by different forms of sensory and social reinforcement across individuals. Unfortunately, one of the limitations of Iwata et al.'s functional analysis (1994) is that when problem behaviour is identified as being maintained by automatic reinforcement, the specific sensory consequences responsible for maintaining the behaviour cannot be determined. Automatically reinforced stereotypy may produce various forms of sensory stimulation (e.g., auditory, visual, or proprioceptive feedback). Therefore, additional assessments may be required to identify the sensory consequences maintaining the behaviour (Rincover et al., 1979).

Previous research found that automatically reinforced stereotypic behaviours decreased when individuals were exposed to an environment providing enhanced specific sensory

stimulation (Hill et al., 2012). However, research investigating the specific sensory modalities that maintain automatically reinforced stereotypy remains limited as most studies focus primarily on identifying the function of these behaviours (Cunningham & Schreibman, 2009). Future research could aim to identify the sensory modalities corresponding to specific stereotypic topographies to enhance assessment.

Interventions

In general, most interventions were effective in reducing stereotypic behaviours, with the exception of sensory integration. The most commonly used interventions in the included studies were response interruption and redirection (RIRD), differential reinforcement (DR)-based interventions, and antecedent-based interventions. Interestingly, antecedent-based interventions were overwhelmingly used to address motor stereotypy, whereas RIRD was disproportionately evaluated for vocal stereotypy. This pattern is consistent with previous reviews (Akers et al., 2020; Mantzoros et al., 2022). The effectiveness of these interventions is not surprising, as their underlying mechanisms align with core principles of applied behaviour analysis. These approaches, including response blocking, reinforcement of functionally equivalent alternative behaviours, and the systematic manipulation of reinforcement contingencies, have been empirically evaluated and shown to reliably reduce behaviours of concern.

Antecedent-based interventions targeting motor stereotypy typically involved altering

sensory or contextual variables that maintain the behaviour. For example, if an individual's motor stereotypy involved repetitive hand tapping on hard surfaces while leaning their ear close to objects to produce auditory stimulation, an antecedent-based intervention might involve cushioning or modifying those surfaces. This proactive approach is particularly suited to motor stereotypy because it is often continuous or rhythmic. Attempting to interrupt each discrete instance of the behaviour as it occurs (e.g., physically blocking every hand tap) may be impractical and could evoke resistance or escalation of behaviour. In contrast, vocal stereotypy tends to be discrete and transient in form. Physical interruption prior to the occurrence of vocal stereotypy is therefore nearly impossible. RIRD typically involves interrupting the vocal stereotypies as they occur and redirecting the individual to emit an appropriate vocal response. For example, when an individual engages in vocal stereotypy, the interventionist may immediately present a vocal task (e.g., request the individual to repeat a specific sound, word or phrase). The redirection may provide similar auditory stimulation which results in reducing engagement in vocal stereotypy while increasing appropriate vocal responding.

Although stereotypy is most commonly maintained by automatic reinforcement in the form of sensory stimulation, the sensory integration therapy (SIT) interventions included in this review were ineffective in reducing stereotypy. This is consistent with previous review, only 12% of the included studies reported clear effectiveness of SIT and 32% showed partial

effects for some participants (Lang et al., 2012). One possible explanation is that SIT does not systematically identify or functionally verify the specific sensory consequences maintaining stereotypy, but instead provides generalised sensory enrichment (Lang et al., 2012). A previous review further reported that only approximately 40% of the environmental enrichment interventions targeting problem behaviours maintained by automatic reinforcement were effective (Gover et al., 2019). In addition, Jeong & Copeland (2020) compared the relative effectiveness of functional behaviour assessment-based interventions (FBAs) and non-functional behaviour assessment-based interventions (NFBAs) and found that FBAs were relatively more effective than NFBAs. This suggests that interventions targeting the specific function of behaviour are more effective than generalised sensory enrichment. Given that the reinforcing sensory consequences of stereotypy are highly idiosyncratic and often unknown, the provision of non-function-matched sensory stimulation is unlikely to reliably compete with automatic reinforcement, which results in inconsistent and mixed outcomes.

Although functional analysis has become a critical and integral component of behavioural intervention, only approximately 65% of the included intervention-based studies conducted a functional analysis prior to intervention to identify the function of stereotypy. This is concerning given evidence that informant-based assessments are less likely to correspond with functional analysis outcomes when behaviour occurs infrequently or when

evocative stimuli are unclear (Yarbrough & Carr, 2000). Since stereotypy is most commonly maintained by automatic reinforcement, which involves private sensory consequences, indirect assessment methods are unlikely to reliably identify behavioural function. Thompson and Iwata (2007) further reported poor correspondence between descriptive assessments and functional analyses. Specifically, they found descriptive methods frequently over-attributing attention, under-attributing escape and tangible functions, and automatically reinforced behaviour was even incorrectly attributed to social consequences. Therefore, to ensure interventions are appropriately matched to the maintaining variables, a functional analysis remains indispensable in practice. Consequently, practitioners should not assume that stereotypy is maintained by automatic reinforcement and should avoid implementing behavioural interventions without first conducting a direct, function-based assessment.

Secondary Findings

Demographic Representation

Over 80% of participants across the included papers were male. This proportion is consistent with previous reviews and ASD prevalence estimates reported by the Centers for Disease Control and Prevention (CDC) in the United States. The Autism and Developmental Disabilities Monitoring (ADDM) Network estimated that, in 2020, about 1 in 36 children under 8 years of age were diagnosed with ASD and 79% of them were male (Maenner et al., 2023). Similarly, a recent study in Norway examined ASD prevalence among approximately

800,000 children (51.3% males and 48.7% females) born between 1998 and 2011 (Posserud et al., 2021). The study found that around 1 in 100 children were diagnosed with ASD, and approximately 81% of these children were male. In addition, a recent systematic review and meta-analysis reported an ASD male-to-female diagnostic ratio of approximately 4:1, which indicates that there are about four boys diagnosed with ASD for every girl (Loomes et al., 2017). More specifically, when examining male and female ratios for motor and vocal stereotypy, previous reviews have also reported a disproportionate representation of male participants (Akers et al., 2020; Mantzoros et al., 2022).

Although this male-to-female diagnostic ratio appears robust, an increasing body of research suggests that some ASD assessment tools exhibit gender biases in RRBI or even stereotypy measurement. This may result in a higher observed prevalence of ASD among males and contribute to the underdiagnosis or underestimation of ASD in females. Tsirgiotis et al. (2022) examined whether there are gender differences in ASD diagnostic assessment using the Childhood Autism Rating Scale-Second Edition (CARS-2; Schopler et al., 2010) and Gilliam Autism Rating Scale-Third Edition (GARS-3; Gilliam, 2013). They found clinically meaningful gender differences in several social communication and RRBI items. On the CARS-2, differences were observed in visual response (e.g., visual stereotypy), verbal communication (e.g., repetitive speech), object use (e.g., repetitive or inappropriate use of objects), imitation, and nonverbal communication. On the GARS-3, differences were found

in behaviours including displaying superior knowledge or skill in specific subjects, intense or obsessive interests in specific intellectual topics, vocal stereotypy, object stereotypy, failure to engage in creative or imaginative play, and failure to follow others' gestures to look at something. These findings suggest that gender biases in ASD assessment tools may contribute to the disproportionate male-to-female participant ratio. Males are more likely to exhibit greater atypicality in these behaviours, whereas females are more likely to show developmentally typical behaviour based on these assessment tools.

On the contrary, there appeared to be no significant gender differences when using the Autism Diagnostic Observation Schedule-Second Edition (ADOS-2; Lord et al., 2012) to assess ASD diagnosis. A previous study found that although males demonstrate more stereotypic behaviours than females in the general population, no gender differences were observed within an ASD sample (Evans et al., 2018). A recent meta-analysis, Cruz et al. (2024), further supported these results, finding that although there are significant gender differences when using the ADOS-2 to assess total ASD symptoms and social interaction deficits no significant differences were observed in measuring RRBIs. Given that there is limited statistical information on how ASD diagnostic assessment tools are implemented worldwide and mixed findings across different assessment tools, it remains unclear whether the disproportionate male-to-female diagnostic ratio reflects measurement bias in commonly used assessment tools or genuine differences in the presentation of ASD across genders.

Interestingly, most of the included papers (6 out of 7) in a previous study reviewed the prevalence and determinants of motor stereotypy in the ASD population did not find a significant association between gender and stereotypy (Melo et al., 2020). Due to the small number of studies available, they were unable to conduct a meta-analysis to determine the overall effect size between stereotypy and gender. These findings highlight the complexity of accurately assessing one of the core features of ASD (RRBIs) with indirect assessment and indicate that current tools may be limited in their ability to fully capture gender differences in stereotypy. The results suggest a need for more direct and sensitive approaches to ASD diagnosis that can better account for potential gender differences in stereotypy.

Limitations and Future Research

Although functional-based interventions, that included function-based assessment, were generally effective in reducing stereotypy, the optimal dosage of these interventions remains unclear. The heterogeneity of stereotypy topography, sensory modalities, maintaining variables, and settings across individuals makes it difficult to determine standardised parameters for intervention intensity, duration, and frequency. Across the included studies, substantial variability was observed in treatment dosage ranging from intensive intervention (e.g., 5 sessions per week) to lean intervention (e.g., 1 to 2 sessions per week). Given that stereotypy is often highly idiosyncratic across individuals, it is unlikely that a standardised intervention dosage can be established. Therefore, behavioural interventions for stereotypy

should be customised to the individual based on the topography of stereotypy, function identified through functional assessment, degree of interference with functional or learning skills and intensity of stereotypy rather than applied using uniform dosage parameters.

Aside from limitations related to intervention dosage, another common limitation across the included studies is that maintenance or generalisation of treatment effects remains relatively underreported. Only approximately one quarter of the included studies examined the maintenance of reductions in stereotypy over time. Furthermore, relatively few studies involved teachers or parents, these non-professionals, as primary intervention implementers. These findings are consistent with previous reviews of motor and vocal stereotypy interventions (Akers et al., 2020; Mantzoros et al., 2022). Given that Baer et al.'s (1968) seven dimensions of ABA highlighted that maintenance, generalisation of behaviour and replicability of intervention procedures, future research should prioritise the development and evaluation of interventions that can be feasibly implemented by non-professional practitioners in a naturalistic setting. By enabling teachers and parents to deliver these interventions, reductions in stereotypy are more likely to be sustained and result in meaningful, long-term benefits for individuals.

In addition to limitations related to maintenance and generalisation of treatment effects, intervention dosage, and limited involvement of non-professional implementers, relatively little attention has been given to the intensity of stereotypy in naturalistic environments and

the extent to which these behaviours interfere with engagement in everyday activities prior to referral. Furthermore, behaviours observed in structured clinical or instructional settings may not readily generalise to naturalistic contexts (Handleman, 1979). Given that it remains unclear to what extent the intensity or topography of stereotypy meaningfully interferes with functional learning in natural settings, to address this gap, the next chapter presents a preliminary study that provides a novel assessment for examining the potential impact of stereotypy on social engagement opportunities for children at high risk for autism.

Chapter 3

Preliminary Study

Introduction

The systematic review in Chapter 2 revealed that limited research has examined the intensity and topography of stereotypy prior to referral. This gap raises a crucial question: whether these stereotypic behaviours significantly interfere with functional learning in daily contexts prior to referral? The current preliminary study aimed to evaluate the use of a novel observational coding system designed to measure and quantify the intensity stereotypy. Once stereotypic behaviours were quantified, the study further explored whether the intensity and topography were related to engagement in parent play bids. This approach could support parents and practitioners in determining whether an individualised stereotypic reduction intervention may be warranted.

Method

Ethic Approval

An ethics modification application to add the University of Waikato researchers to the existing ethics approval was submitted on 29 October 2025 (see Appendix A). The ethics committee approved the modification and confirmed that we were added to the ethics approval on 30 October 2025 (see Appendix B). The ethics approval was renewed (see

Appendix C) and confirmed on 6 March 2026 (see Appendix D).

Sample Extraction

This preliminary study uses secondary data from a larger grant-funded project at the Child and Adolescent Policy Research Institute at the University of Texas at San Antonio (UTSA), where Dr. Carnett holds a research appointment. Project PLAAY was led by Dr. Neely and focuses on developing pre-emptive intervention for infants and toddlers aged 6 to 36 months who are at risk of ASD. Risk status is determined based on Autism Parent Screen for Infants (APSI; Bryson et al., 2008) and Modified Checklist for Autism in Toddlers, Revised With Follow-up (M-CHAT-R/F; Robins et al., 2014) scores and/or having a sibling diagnosed with ASD. Most sessions were conducted in the UTSA research clinic, which was set up to mirror an early childhood learning environment (see Figure 6). Some participants facilitated their sessions via telehealth due to the COVID-19 pandemic. However, none of the participants included in this preliminary study were assessed remotely. In the initial session, parents were instructed to play with their child as they would normally do while researchers recorded their interaction for five minutes. Researchers did not provide any feedback during this session. To protect participant confidentiality, pseudo names were assigned to each child. For this preliminary study, only data from the initial session were analysed. Video recordings were initially screened for inclusion by UTSA researchers to identify non-intervention (baseline) parent-child play session that were used for the current study.

Figure 6

The Laboratory Setting at UTSA for PLAAAY Sessions



Note. Participating parents and children were free to use any toys available in the room.

Researchers were positioned at the side of the room during sessions.

Coding Development

Operational definitions of play were established by reviewing existing measures of stereotypy, the prior literature, and through consultation with Dr. Lang, the first author of *Increasing Play and Decreasing Stereotypy for Children with Autism on a Playground* (Lang et al., 2020). A 10-s partial interval recording system was adopted, as it was consistent with the assessment procedures used in the aforementioned study (Lang et al., 2020) and conducive for the data sample.

Intensity of stereotypy was measured using a Likert scale consistent with the most

commonly used indirect assessment tools identified in the systematic review, including Gilliam Autism Rating Scale-Second Edition (GARS-2; Gilliam, 2006), Repetitive Behavior Scale-Revised (RBS-R; Bodfish et al., 2000) and Aberrant Behavior Checklist (ABC; Aman et al., 1985), which use a four-point rating scale ranging from 0 (never) to 3 (frequently observed or a severe problem). However, the rating scale was adapted and modified to a five-point scale to reflect the total duration of stereotypy observed during each five-minute session.

Coding Procedure

The parent play videos were then coded by a master's student using a 10-s partial interval recording system across the five-minute parent play session following the procedures:

- (1) A “+” was marked for the corresponding interval when the child exhibited any form of stereotypy (including motor and vocal stereotypy) as well as the topography. If more than one topography was observed across the session, the total duration of each topography was specified. Examples of stereotypy topographies for each category are presented in Table 6 (reproduced from Table 1 in Chebli et al., 2016).
- (2) The intensity of stereotypy was rated using a five-point scale based on the total duration of stereotypy observed across the five-minute session using a 10-s partial interval recording. The coding scale consisted of the following codes: 1 = total

duration less than 1 minute; 2 = total duration between 1 and 2 minutes; 3 = total duration between 2 and 3 minutes; 4 = total duration between 3 and 4 minutes; 5 = total duration between 4 and 5 minutes.

- (3) Play bids were coded as events. If a single play bid extended across multiple 10-s intervals, it was recorded only once. The type of parent play bid was coded as one of the following: a) New play: The parent offers a bid for play with vocal expression (e.g., a vocal invitation “Do you want this?”); b) Additive play: The parent engages by expanding on what the child is doing (e.g., offering the child a related toy, engaging the child with relevant materials, making a comment related to the play the child is currently engaging in); c) Unrelated play or response redirection: The parent bids for the child to engage in play to redirect the child from exhibiting stereotypic behaviours.

- (4) Child engagement with the play bid was recorded (engaged or did not engage).

Similarly, child engagement was coded in relation to each play bid rather than per interval.

- (5) If the child did not engage, the child’s behaviour during that interval was coded (e.g., continuing engagement in stereotypy, continuing engagement with play materials, leaving the area).

- (6) The IOA coders needed to practise coding using example video clips from the

original dataset that were not included in the final analyses before conducting IOA coding. If at least 80% of agreement was reached, the IOA coders were considered sufficiently trained to begin coding the IOA videos. If agreement was below 80%, the primary coder and the IOA coder reviewed the discrepancies together and the primary coder provided additional clarification on the coding procedures (e.g., If a parent initiated a new play bid within an interval and continued to comment on the behaviour or extend the ongoing interaction, IOA coders coded the new play bid only in the initial interval, as subsequent interactions considered part of the same play episode) before IOA coder practised coding another example clip. Practises continued until at least 80% of agreement was reached.

Operational Definition

Motor stereotypy was defined as invariant, repetitive behavioural movements that appear to serve no clear external social purpose (Rapp & Vollmer, 2005) whereas vocal stereotypy was defined as repetitive vocalisations that serve no clear external social purpose (Lanovaz & Sladeczek, 2012). Given that the topographies of stereotypy varied across participants, the operational definitions were individualised for each participant. We identified corresponding operational definitions for each topography from previous research and adapted them for our participants. Given that stereotypy topographies similar to those observed in Evelyn and Eric have been well defined in previous studies, identical operational

definitions were adopted from Loftin et al. (2008) and Pastrana et al. (2013). Detailed operational definitions for each participant are presented in Table 7.

Interrater Reliability

The first rater extracted the videos after they were initially screened by the UTSA researchers to identify the initial parent play session within each intervention clip. Once the initial parent-child play sessions were identified, the first rater applied the coding procedures to code each video. A second rater independently coded all included videos ($N = 6$). Overall agreement was 84.6%. Detailed interrater reliability for each participant is presented in Table 8.

Extraction Results

A total of 86 participants were enrolled in the UTSA parent-led treatment for children at high risk for ASD project. After the initial screening conducted by UTSA researchers, 80 participants were excluded (34 due to inaccessible participant videos, 18 due to participants who did not exhibit stereotypic behaviours, and 28 due to the unavailability of initial parent-child play session video clips) and six participants met the inclusion criteria. All six participants received a formal diagnosis of ASD following their participation in the host study.

Table 6*Examples of Stereotypy Topographies in Each Category*

Category	Examples
Whole body	Rocking; clenching-stiffening-posturing; whole body stereotypy; body and torso tensing movements
Head	Head movements; head nodding; head rolling
Hand/Finger	Hand, finger movements or mannerisms; hand flapping or shaking; finger wiggling; waving or shaking arms
Locomotion	Whirling, turning around; pacing; jumping; bouncing; running; twirling (on one's self)
Object	Repetitive use of objects; watching same video continuously; twirling things; spinning or manipulating objects
Sensory	Gazing; rubbing self; repetitive behaviour involving sensation; sniffing objects; eye/vision; ear/hearing; mouthing
Vocal	Yelling; screaming; repetitive talk about one topic or use of language; echolalia; verbal rituals; facial grimacing and vocalisation

Note. Reproduced from Table 1 in Chebli et al. (2016).

Table 7*Operational Definitions of Stereotypy for Each Participants*

Participants	Operational definitions
Sebastian	Any instance of noncontextual repetition of the vocal emission “aha, aha, aha”
Jarvis	Any instance of noncontextual repetition of the vocal emission “mmm, mmm, mmm”
Ericka	Any instance of noncontextual repetition of the vocal emission “aha, aha, aha
Evelyn	Any instance of clapping that was unrelated to environmental events occurred two or more times within five seconds.
Eric	Any instance of noncontextual repeated (two or more back-and-forth movements) of the arm from the elbow or the hand from the wrist with or without an object in hand within five seconds
Lucy	Any instance of noncontextual repetition of outward-then-inward extension of both legs from a bent position while in the starting push-up position

Note. Operational definitions for Evelyn and Eric’s were reproduced from Loftin et al. (2008) and Pastrana et al. (2013), respectively.

Table 8*Summary of Participant Engagement, Play, and Stereotypy Measures*

Participant	DoS	SES	IR	NP	AP	UP/RR	ER	PBMS	PBMTI/AB	IRR
Sebastian	80	26.7%	2	1	12	0	76.9%	0%	100%	82.2%
Jarvis	200	66.7%	4	11	8	0	63.2%	0%	100%	84.4%
Ericka	80	26.7%	2	4	6	0	90%	0%	100%	88.9%
Evelyn	30	10%	1	4	10	0	64.3%	0%	100%	85.6%
Eric	80	26.7%	2	4	13	0	76.5%	0%	100%	83.3%
Lucy	50	16.7%	1	9	8	0	58.8%	71.4%	28.6%	83.3%

Note. DoS refers the duration of stereotypy and is reported in seconds. SES refers to percentage of 5-minute session exhibited stereotypy. IR refers to intensity rating. NP refers to new play and is reported in times. AP refers to additive play and is reported in times. UP/RR refers to unrelated play or response redirection and is reported in times. ER refers to engagement rate. PBMS refers to percentage of play bids missed due

to stereotypy. PBMTI/AB refers to percentage of play bids missed due to tangible items or alternative behaviours. IRR refers to interrater reliability.

Assessment Results

Only one topography was observed for each participant (3 motor stereotypy and 3 vocal stereotypy). The total duration, using a 10-s partial-interval recording system, of stereotypic behaviours varied across participants, ranging from 30 to 200 seconds within the 5-minute parent play session, which corresponded to 10-66.7% of the session. The intensity of stereotypy was mostly rated as 1 or 2 for five of the six participants (83.3%) which indicates that the total duration of stereotypic behaviours for most participants was less than 2 minutes (see Table 8 for more details).

The number of observed parent play bid invitations varied across participants, ranging from 10 to 19 bids across the 5-minute session. The number of play bids offered by parents also varied across participants, ranging from 1 to 11 new play and 6 to 13 additive play. No unrelated play or response redirection were observed (see Table 8 for more details).

During the 5-minute parent play session, children often responded to parent play bid invitation (including new play and additive play), with engagement rates ranging from 58.8% to 90%. When children did not engage in the parent play bid invitations, most participants (5 out of 6, 83.3%) engaged with other tangible items or alternative behaviours (e.g., toys on the other side of the room, leaving the play area). The only exception was participant Lucy. In some instances, her disengagement occurred because she began engaging in motor stereotypy. Her percentage of parent play bids missed due to stereotypy was 71.4% (see more

details in Table 8).

Given that Lucy had the lowest engagement rate and missed 71.4% (5 out of 7) of her mother's play bids due to stereotypy, she demonstrates a high need for intervention to address the stereotypy. Although Sebastian, Jarvis, Evelyn, and Eric showed moderate engagement rates (between 63% and 77%), none of their missed play bids were attributed to stereotypy but related to engaging with tangible items or other alternative behaviours. Their current need for an intervention to address stereotypy appears low. However, continued monitoring is recommended in case missed play bids due to stereotypy increase over time. Given that Ericka missed only one play bid while focusing on the toy she was playing with, it is possible that she did not notice the play bid. At this stage, she does not require intervention.

Discussion

The current preliminary study aimed to evaluate the use of a novel observational coding system designed to quantify stereotypy and examine its potential relationship with engagement in parent play bids among children at high risk of ASD. In contrast to prior indirect assessments of stereotypy in ASD, this approach uses direct observation in a naturalistic environment which provides more accurate measurements of the frequency and intensity of stereotypic behaviour. Additionally, this approach may help determine whether individualised intervention is warranted by assessing stereotypy directly within the everyday parent-child play context. To our knowledge, this is the first study to attempt to develop a

direct assessment tool that helps to quantify and evaluate stereotypy using direct observation within a naturalistic context.

The proposed assessment method demonstrated strong reliability and utility in identifying and quantifying stereotypy across participants. Interrater reliability ranged from 90% to 100% for all children, which indicates that the coding procedures and operational definitions were applied consistently. Beyond reliably detecting stereotypy, the proposed direct observation coding procedure provides a potential quantitative framework for examining the relationship between stereotypy and parent play bids. Given that previous research that has primarily relied on indirect caregiver report, the ability to quantify stereotypy using an accessible coding system may support future research in more accurately evaluating the relationship between stereotypy and other variables.

Our preliminary results suggest that for the participants included in this sample, most often, stereotypy (including vocal and motor stereotypy) did not hinder parent play bid or social engagement. Stereotypy did not account for any missed parent play bids for five out of six participants. Disengagement in these participants were due to prioritising tangible items or alternative behaviours. Within this sample, the intensity or topography of stereotypy did not predict parent play bid either. For example, although Jarvis exhibited severe motor stereotypy, their percentage of immediate engagement following parent play bids was similar to that of Evelyn, who displayed only mild stereotypy across the session. In contrast, Lucy

exhibited mild stereotypy but demonstrated the lowest level of immediate engagement. She got distracted by tangible items or ignored parent play bids while showing a strong preference for engaging in stereotypic behaviour. This pattern not only further illustrates that higher stereotypy severity does not necessarily correspond to lower social engagement but also suggests that reducing stereotypy for children at high risk of ASD may not be necessary even among those with similar rates and intensities of stereotypy.

During the five-minute play session across six participants, only one participant, Lucy, prioritised engaging in motor stereotypy over responding to parent play bids whereas no direct relationship between stereotypy and parent play bids was observed in the other participants. This is inconsistent with an earlier review by Lanovaz et al. (2013) which suggested that stereotypy is negatively correlated with learning adaptive skills and therefore engaging in stereotypy impedes developmental progress by limiting opportunities to engage in appropriate behaviours. One possible explanation for this discrepancy is that the participants included in the review may have exhibited topographies of stereotypy that are incompatible with certain adaptive skills (e.g., hand clapping may interfere with shaking hands). Therefore, individuals who engage more frequently in stereotypy may have fewer opportunities to learn or perform adaptive skills, resulting in a negative association between stereotypy and the development of adaptive skills. However, this explanation may not fully account for situations in which stereotypy is compatible with adaptive behaviours or when

the intensity or frequency of stereotypy is low.

Another possible explanation is a methodological limitation in the interpretation of the review. Lanovaz et al.'s conclusion was based on patterns observed across the included studies where reductions in stereotypy were often accompanied by increases in other behaviours rather than on formal correlational analyses. Based on these patterns, they concluded that stereotypy and the development of adaptive skills are negatively correlated and even imply a causal relationship. Although clinically meaningful changes should not be overlooked, purely observing co-occurring changes (either reductions or increases) in behaviours does not necessarily indicate that a correlation is established or statistically significant. Therefore, the validity of this strong conclusion remains unclear and the reported relationship should be interpreted cautiously.

Previous research reported that their participants were referred to intervention studies because vocal stereotypy interfere with social or academic activity (Gibbs et al., 2018). Interestingly, both Sebastian and Jarvis respond to the parent play bids while exhibiting vocal stereotypy in some instances. This result is not surprising given that parent play bids are not inherently incompatible with vocal stereotypy, individuals can exhibit vocal stereotypy while simultaneously responding to social interaction. However, the role of compatible socially appropriate behaviours should not be overlooked. Previous research has shown that implementing compatible motor RIRD (redirecting individuals to imitate gross motor

behaviour when vocal stereotypy occurs) can be as effective as incompatible vocal RIRD in reducing vocal stereotypy (Ahrens et al., 2011; Shawler & Miguel, 2015). These findings highlight that socially appropriate behaviours (e.g., social engagement) that are compatible with vocal stereotypy may have the potential to serve as alternative responses for reducing vocal stereotypy in naturalistic settings.

Our findings also highlight the importance of direct assessments. Previous research shows that indirect assessments may not always accurately capture the results of direct assessments. For example, Iwata et al. (2013) compared the results of an indirect assessment questionnaire (the Functional Analysis Screening Tool; Iwata et al., 2002) with experimental functional analyses and found that the indirect assessment accurately predicted behavioural function in approximately 60% of cases. However, direct assessment does not always result in more accurate assessment, its utility depends on the design and the target variables. For example, Tarbox et al. (2009) found that descriptive assessments often failed to identify clear behavioural functions in children with autism whereas indirect and experimental assessments were generally successful. Similarly, Thompson and Iwata (2007) compared outcomes from descriptive analyses and functional analyses and found that only approximately 25% of cases showed agreement between the two methods. Taken as a whole, our findings are consistent with these studies and highlight the importance of using multiple assessment tools (including both direct and indirect) as relying solely on indirect measures may fail to capture important

behavioural patterns. Therefore, it is crucial to increase the use of direct assessments when measuring stereotypy and other variables.

Implications and Applications

Findings from our preliminary study suggest that practitioners should consider using direct assessment to determine whether intervention is necessary to address stereotypical behaviour. Although participants exhibited stereotypy, only one participant's engagement was meaningfully impeded by stereotypy. The remaining participants did not demonstrate functional impairment while engaging in stereotypy. Furthermore, in some cases, participants even responded to social bids while exhibiting vocal stereotypy. Therefore, conducting direct assessments prior to referral or intervention may enable practitioners to more accurately quantify the functional impact of stereotypy and avoid unnecessarily targeting individuals for stereotypy reduction when intervention is not clinically appropriate.

From an applied perspective, current results suggest that for individuals who demonstrated moderate to high engagement rates and did not miss parent play bids due to stereotypy, ongoing monitoring of engagement, stereotypy frequency, and potential functional interference may be sufficient while continuing to provide enriched play opportunities. In contrast, for individuals who showed low engagement and whose missed play bids were directly associated with stereotypy, further functional assessment (e.g., functional analysis) is warranted, followed by individualised stereotypy reduction intervention. Tailoring

individualised intervention plans in this way can help participants maximise the benefits of intervention and enhance their long-term quality of life.

To support these decision-making individualised intervention planning processes, our proposed novel system could provide the foundation for precisely measuring stereotypy. A practical next step for the field is to develop standardised, validated tools base on this system to quantify the intensity and frequency of stereotypies, as the current measurement tools largely rely on vague frequency scales (e.g., "sometimes," "often"). Given that these scales are limited by subjective, non-quantifiable reports, it can be challenging to accurately assess whether stereotypic behaviours actually impede adaptive functioning. Once a reliable, quantifiable, empirical measurement tool is established, practitioners and parents can more confidently determine whether individualised intervention to reduce specific stereotypies is necessary.

Lastly, an implication of our preliminary study is that reducing stereotypy may not be universally necessary across all topographies and individuals. Rather than treating stereotypy as a problem behaviour and referring children to research or intervention whenever parents or caregivers observe an elevated level, stereotypy could be understood as a normal developmental behaviour or personal trait, particularly when it does not significantly interfere with learning, play, or daily functioning.

Limitations and Future Directions

Although the findings of this preliminary study hold promise for the inclusion of a more wholistic approach to the direct assessment of stereotypy, there are a few limitations that warrant consideration and the results should be interpreted cautiously. The most significant limitation is the small sample size. After screening and excluding participants who did not exhibit stereotypy during the play session, only six participants were included in this preliminary study which limited the scope of our analysis using the pilot assessment tool. Consequently, it remains unclear whether this assessment tool is reliable for determining if stereotypy hinders social engagement. Furthermore, the small sample size also limits the establishment of precise operational definitions for categorising intervention needs (low, moderate, and high) based on the assessment outcome. Therefore, replication with a larger sample is needed to empirically validate the current findings and refine the operational definitions used to guide intervention decisions.

A second limitation is the limited opportunities for participants to choose between engaging in stereotypy and responding to parent play bids. Although, on average, parents initiated play bids every 20 seconds across the five-minute play session, these bids did not always occur at times that coincided with the participants' engagement in stereotypy. Given that the timing of stereotypic behaviours is unpredictable, it is nearly impossible for parents to provide a play bid exactly when their child is about to engage in stereotypy. A possible solution would be to extend the duration of observation sessions, collect multiple sessions or

conduct sessions across multiple settings. With more observation instances, participants would have more opportunities to make choices between engaging in stereotypy or responding to parent play bids which would make the findings more robust and rigorous.

A third limitation relates to the use of video data. At times, participants moved out of the camera frame, and the fixed camera angle did not consistently capture all of the participants' behaviour. Even when participants were within the frame, observable behaviours may have been missed due to the fixed angle of camera and movement of the child (e.g., the child turning their body to the side, or with their back facing the camera). In addition, audio quality was occasionally compromised when multiple individuals were speaking simultaneously or making vocalisations, which may have affected behavioural coding accuracy. Future research could use multiple cameras to capture 360° views of the room, along with improved audio equipment, to ensure that all behaviours of children and parents are recorded.

Lastly, the fourth limitation might be the Hawthorne effect (Landsberger, 1958). Although parents were instructed to play with their child as they typically would, some parents could have altered their behaviour during the play sessions (e.g., providing more or less play opportunities for the child). For example, several parents repeatedly held their child's hand to prompt engagement with play bids to comply with the brief instruction to "play with your child for approximately five minutes" which may not reflect typical parent-child interactions. Future study should incorporate larger samples and primary data collection

across different naturalistic settings (e.g., homes, community settings) to further refine and standardise this pilot quantification methodology so that both the validity and generalisability of the findings are strengthened.

Chapter 4

General Discussion and Conclusion

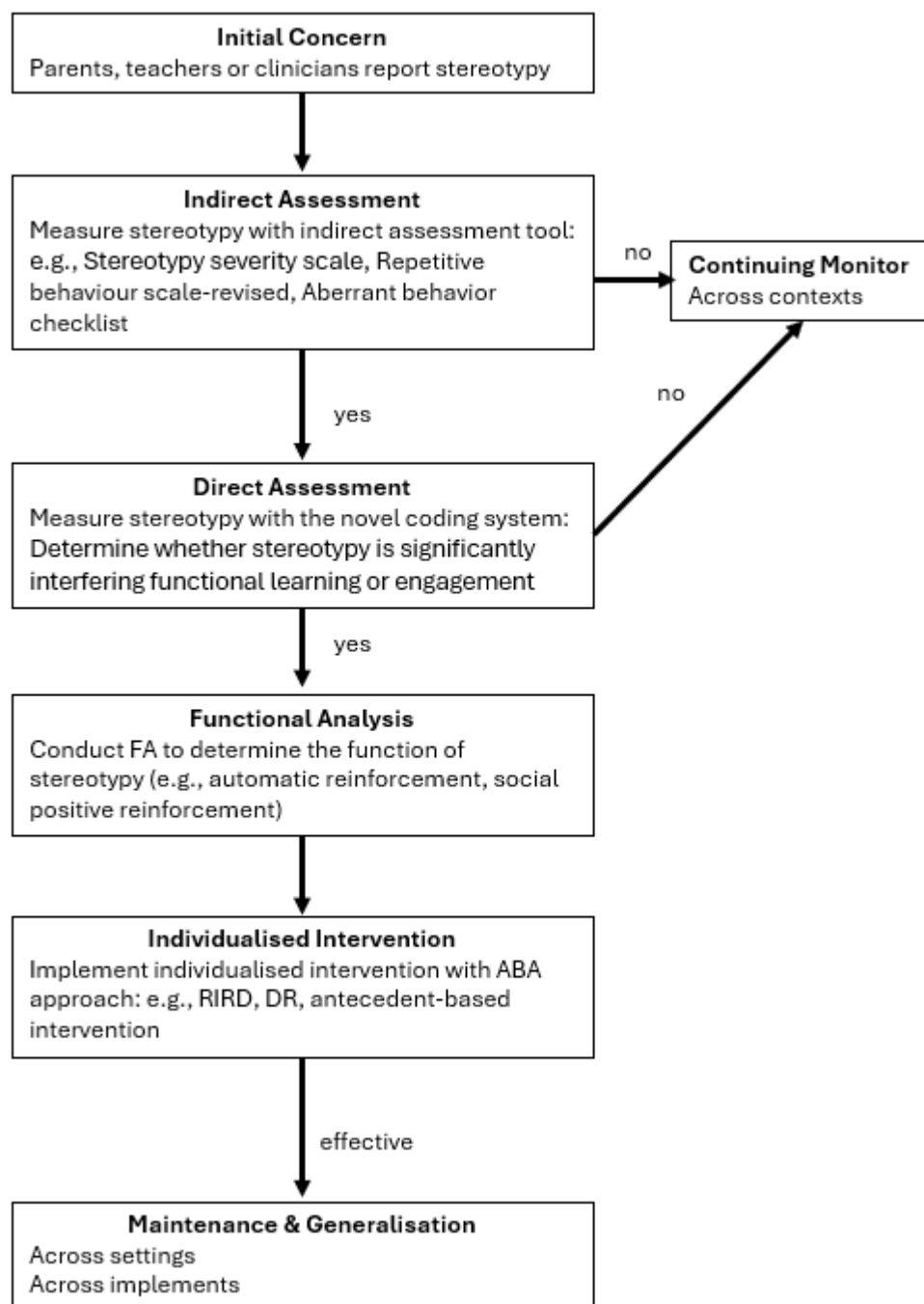
The current thesis comprehensively examined the literature related to the assessment, measurement, and treatment of stereotypy and extended these findings through a preliminary observational assessment study. Collectively, the results indicate the utility and accuracy of direct assessment of stereotypy to determine the impact on social learning which may help to evaluate whether there is a need for intervention. Further, the preliminary results of the assessment study suggest that stereotypy may not necessarily function as a barrier to social engagement for children at high risk of ASD. These findings challenge existing clinical pathways and indicate that re-evaluation of current decision-making procedures may be beneficial particularly when limited engagement that actually impedes learning in naturalistic contexts.

The systematic review revealed substantial variability in stereotypy assessment and interventions. Although these interventions were generally effective in reducing stereotypic behaviours, procedures related to initial identification, pre-referral assessment, and evaluation of maintenance and generalisation were often neglected and underreported. A notable proportion of intervention-based studies did not even conduct a functional analysis prior to treatment implementation, despite targeting stereotypy as a behaviour of concern. These patterns suggest that assessment and decision-making processes within the literature are not

always consistently aligned with core principles of ABA. Therefore, the development of an assessment framework that adheres to Baer et al.'s (1968) seven dimensions of ABA may enhance the effectiveness and efficiency of stereotypy reduction.

Figure 7

Stereotypy Assessment and Intervention Decision-Making Framework



Based on the collective findings of the systematic review preliminary study highlight the importance of developing a standardised assessment framework as well as the value of conducting direct pre-referral assessment procedures. A detailed stereotypy decision-making flowchart is presented in Figure 7. If treatment effects are not maintained over time, the process should be reinitiated at the previous stage. Similarly, during the monitoring stage, if additional stereotypy emerges, the process should return to the previous assessment stage and be reassessed using direct or indirect assessments.

Our preliminary results suggested that the intensity of stereotypy did not reliably predict engagement outcomes. Given that most participants disengaged due to access to tangible items or engaged in alternative behaviours rather than stereotypy itself, the presence of stereotypy alone may not necessarily indicate the need for intervention. This extra step of pre-referral direct assessment not only refines the procedures that were often neglected in the existing literature but also serves as a reminder for clinicians to implement interventions that align with the core principles of ABA.

Taken together, the findings from the literature review and preliminary study recommend a standardised assessment framework consisting of the following procedure. Once stereotypy was observed or identified through indirect assessment completed by parents or caregivers, a direct assessment should be conducted to determine whether the reduction of stereotypy is socially significant to individuals and stakeholders. If stereotypy is confirmed to

interfere with learning or social interactions it should be followed by a functional analysis to determine the function of the stereotype. After identifying the functional relation, a clear and detailed individualised intervention based on behavioural principles should be developed.

Beyond considerations related to assessment procedures, the present findings further emphasise the importance of individualised intervention planning. When intervention is pursued solely on the basis of the presence of stereotype reported by parents, without evaluating its functional impact, clinical resources may not be efficiently allocated to individuals who require more intensive support. In contrast, individualised intervention planning that includes dynamic monitoring of outcomes to evaluate meaningful change and ensures that behaviour change is generalised across settings and contexts can support more targeted and efficient use of clinical resources.

In conclusion, this thesis proposes a novel coding system for quantifying stereotype following indirect assessment which is often completed by non-professionals. The proposed system not only provides a more structured evaluation of whether stereotype significantly interferes with functional learning and social engagement among children at high risk of ASD but also addresses gaps that have been underreported or neglected in previous literature. A refined stereotype assessment and intervention decision-making framework is further proposed as not all occurrences of ASD-related behaviours necessarily require intervention.

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[2024-25-annual-data-explorer/_w_f3d906e2c1824a95991d2a2e8479055e#!/explore-](https://minhealthnz.shinyapps.io/nz-health-survey-2024-25-annual-data-explorer/_w_f3d906e2c1824a95991d2a2e8479055e#!/explore-indicators)

[indicators](https://minhealthnz.shinyapps.io/nz-health-survey-2024-25-annual-data-explorer/_w_f3d906e2c1824a95991d2a2e8479055e#!/explore-indicators)

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Appendix A

Acknowledgment of Modification to Existing Ethics Approval



Office for Research and Innovation

TO: Leslie Neely, Leslie Neely, Katherine Holloway, Cha Patterson, Russell Lang, Amarie Carnett, Hung Chun Lin
COEHD EDUC PSYCHOLOGY

FROM: Office of Research Integrity

DATE: Oct 29, 2025 4:47:23 PM CDT

RE: Notice of Receipt of Modification Submission on Oct 29, 2025 4:47:23 PM CDT

STUDY #: FY23-24-42

STUDY TITLE: Parent-Lead Autism Treatment for At-Risk Young Infants and Toddlers (Project PLAAY)

Your IRB submission for the above-referenced study has been received by the Office of Research Integrity via Cayuse IRB. You will be notified if further information is needed and when this has been reviewed and approved.

University of Texas at San Antonio

Office of Research Integrity, One UTSA Circle, San Antonio, TX 78249
IRB@utsa.edu

Note. Hung Chun Lin is my legal Chinese name whereas Michael Lin is my preferred English name.

Appendix B

Confirmation Email of Being Added to the Ethic



Office for Research and Innovation

October 30, 2025

Dear Leslie Neely:

The IRB acknowledges and approves your updated list of study personnel for:

Type of Review: Modification

Title: Parent-Lead Autism Treatment for At-Risk Young Infants and Toddlers (Project PLAAY)

Principal Investigator: Leslie Neely

IRB Number: FY23-24-42

Co-PI: Amarie Carnett, Katherine Holloway, Cha Patterson, Russell Lang, Hung Chun Lin

Documents reviewed: Modification

Sincerely,

Shannon Marquess

IRB Member

Designee of the Chair

Senior Research Compliance Coordinator

UTSA Office of Research Integrity - IRB Office

irb@utsa.edu

Note. Hung Chun Lin is my legal Chinese name whereas Michael Lin is my preferred English name.

Appendix C

Acknowledgment of Ethics Approval Renewal



Office for Research and Innovation

TO: Leslie Neely, Leslie Neely, Katherine Holloway, Cha Patterson, Russell Lang, Amarie Carnett, Hung Chun Lin
COEHD EDUC PSYCHOLOGY

FROM: Office of Research Integrity

DATE: Mar 6, 2026 9:14:17 AM CST

RE: Notice of Receipt of Modification Submission on Mar 6, 2026 9:14:17 AM CST

STUDY #: FY23-24-42

STUDY TITLE: Parent-Lead Autism Treatment for At-Risk Young Infants and Toddlers (Project PLAAY)

Your IRB submission for the above-referenced study has been received by the Office of Research Integrity via Cayuse IRB. You will be notified if further information is needed and when this has been reviewed and approved.

University of Texas at San Antonio

Office of Research Integrity, One UTSA Circle, San Antonio, TX 78249
IRB@utsa.edu

Note. Hung Chun Lin is my legal Chinese name whereas Michael Lin is my preferred English name.

Appendix D

Confirmation Email of Ethics Approval Renewal



Office for Research and Innovation

March 6, 2026

Dear Leslie Neely:

The IRB acknowledges and approves your updated list of study personnel for:

Type of Review: Modification

Title: Parent-Lead Autism Treatment for At-Risk Young Infants and Toddlers (Project PLAAY)

Principal Investigator: Leslie Neely

IRB Number: FY23-24-42

Co-PI: Amarie Carnett, Katherine Holloway, Cha Patterson, Russell Lang, Hung Chun Lin

Documents reviewed: Modification

Sincerely,

Shannon Marquess

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Note. Hung Chun Lin is my legal Chinese name whereas Michael Lin is my preferred English name.