Comparing AAC Modalities in Functional Communication Training for Adults with Developmental Disabilities: A Study on Preference and Maintenance

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Abstract

While Functional Communication Training (FCT) has been widely validated in child's populations, its effectiveness among adults with developmental disabilities (DD) remains underexplored in the literature. Modern FCT increasingly emphasises selecting an augmentative and alternative communication (AAC) modality that fits the individual and is preferred by them, as this can directly influence acquisition speed, maintenance of the functional communication response (FCR) and risk of problem behaviour relapse. This study evaluated a function-based approach to reducing problem behaviour and strengthening functional communication for an autistic adult with DDs and limited verbal communication. Building on prior work, the study aimed to (a) identify an individually preferred mand topography following differential training of two AAC modalities and (b) test the durability of that preferred modality when embedded within FCT, including delay and denial tolerance training (DDTT). Using a single-subject design, a 25-year-old adult participant with history of problem behaviours was systematically exposed to phases of FCT intervention including DDTT. The result of the study demonstrated a fast acquisition rate when the preferred AAC modality was used and the suppression of problem behaviour using competing stimuli during tolerance training. The findings underscore the clinical implications of embedding AAC modality evaluation and preference assessment within FCT and systematic DDTT to promote durable functional communication and behavioural stability in real-world adult service contexts.

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Introduction

Developmental Disability, Complex Communication Needs and Problem Behaviour

Developmental disability (DD) is an umbrella term that describes the conditions of an individual that originate in the developmental period and are associated with differences or delays in cognition, communication, movement, learning or social interaction that are likely to persist across their lifespan. According to DSM-5-TR (American Psychiatric Association, 2022), this population encompasses individuals with intellectual disabilities (ID), autism spectrum disorder (ASD), attention-deficit/hyperactivity disorder (ADHD), communication disorders, specific learning disorder and motor disorders. The global prevalence of DD for children under five is approximately at 8.4%, with approximately of 95% of which are from low and middle-income countries (LMICs) (Kahonde & Boot, 2024), where impacts of disability reduced participation and health inequities can persist into adolescence and adulthood if therapeutic resources are not provided throughout the lifespan. In the United States, it is estimated that 2.21% of adults have autism spectrum disorder (ASD), which corresponds to approximately 5.44 millions of adults in the country (CDC, 2025) and is estimated to be 3.4 times more common in boys than girls (Allen et al., 2023). Furthermore, intellectual disability disorder (IDD) is reported to have a prevalence of between 1–3% (McKenzie et al., 2016; Marrus & Hall, 2017).

Across diagnostic categories, two individuals with the same diagnosis can show very different strengths, needs and developmental trajectories. For instance, two autistic individuals can meet the same diagnostic criteria, yet one may have fluent speech while the other may be non-vocal (e.g., non-speaking) and require intensive support. Additionally, comorbidity of other diagnoses is very common among this population, for example autistic individuals may also meet criteria for ID, language disorder, ADHD, anxiety or motor coordination difficulties (Memisevic & Hadzic, 2013; Marrus & Hall, 2017).

Complex communication needs (CCN) refer to situations in which an individual's communication is significantly limited because speech alone is insufficient to meet daily goals. Within ASD and DD populations, it is estimated that approximately 30% have little or no spoken language (Allen et al., 2023). Further, it is estimated that approximately 75% of individuals with DD and CCN engage in problem behaviours as an attempt to communicate or to express their needs and wants (Maltman et al., 2020; Marrus & Hall, 2017). Although some individuals may speak a few words, their message can be unclear and individuals may rely on non-vocal or other idiosyncratic communicative behaviours, such as eye gaze, facial expression, gesture and body movement. However, these abilities may remain stable, improve or decline over time as the individual's medical, motor, sensory and cognitive factors vary widely (Maltman et al., 2020), thus producing very different communication patterns. Although individuals with CCN are candidates for Augmentative and Alternative Communication (AAC) systems, approximately 91% of adults with CCN are unable to participate in daily routines and community contexts due to the lack of suitable AAC systems to support their daily communication needs (Light & Mcnaughton, 2015). Thus, recent work has begun to outline structured and evidence-based procedures for selecting and teaching AAC modalities for autistic individuals with limited speech, using multi-phase assessments that incorporate both caregiver input and individual's preference when identifying an initial AAC modality, including within the context of supporting problem behaviour (Carnett et al., 2025; Kunnavatana et al., 2018; Ringdahl et al., 2018).

Problem behaviour (e.g., challenging behaviours, behaviours of concern, maladapted behaviours, severe behaviours), an umbrella term that refers to the behaviour that most people see as a "problem within a person", is in fact most often a form of communication that is shaped by the environmental contingencies (Beavers et al., 2013; Carr & Durand, 1985; Melanson & Fahmie, 2023; Tiger et al., 2008). Common example of problem behaviours

include aggression (e.g., hitting, kicking, biting, hair-pulling), self-injury (e.g., head-hitting, skin-picking, self-biting), property destruction (e.g., breaking objects, throwing items), elopement (e.g., leaving supervision or designated areas, bolting across roads or carparks) and more. When someone has a limited communication repertoire, whether they are born with it or due to injuries or illnesses, they may be less able to access socially valid ways of getting their wants and needs met. In such circumstances, behaviours that people around find disruptive or jeopardise the safety of the individual or others can often reliably produce important outcomes for the individual (e.g., gaining attention or escaping an aversive situation). In other words, these individuals use problem behaviour as a method of communication to express or achieve their needs and wants (Carr & Durand, 1985; Iwata, Dorsey, et al., 1994; Northup et al., 1991). Often, these behaviours can cause significant impacts to the individual's wellbeing and autonomy, for instance physical injury, exclusion from school or community settings and reduced opportunities to learn and socialise (Chung & Corbett, 1998; Hensel et al., 2011; Smith et al., 2020). If left unaddressed, these behaviours can result in a cycle of increasing restrictions that subsequently reduces their quality of life (QoL).

Adult Populations

While considerable attention has been given to early intervention and school-age services, adult supports are often being neglected (Bowring et al., 2017), particularly in addressing problem behaviours and communication needs. In addition, it has been suggested that adults with DDs have limited access to AAC services, with New Zealand indicating a marked skew towards service delivery in childhood and early schooling rather than adulthood (Sutherland et al., 2005). This creates a significant decrease in care and structured services once individuals transition out of the school system. Due to this fall short, an estimate of 20% to 50% of the adults with DDs engage in problem behaviours (Álvarez-Couto, 2024; Bowring

et al., 2017; Poppes et al., 2010). These behaviours are too often perceived as merely disruptive or "non-compliant", rather than recognised as functional responses or a learned behaviour that allow the individual to access to a desired outcome (Iwata, Dorsey, et al., 1994). Subsequently, the absence of consistent and adult-focused support systems exacerbates these challenges and restricts opportunities to participate in community, education and employment (Smith et al., 2020).

The majority of this population live in community-based residences or group home, supported by direct service providers (DSPs) (e.g., support staffs or day programme providers) in assisting their daily living activities (Chung & Corbett, 1998; Hensel et al., 2011). This includes supporting their personal care, meal preparation, transportation, daily programmes, social life and skills training. However, working with these individuals who exhibit problem behaviours can place significant emotional and physical demands on families and DSPs (Hensel et al., 2011). Smith et al. (2020) reported in a survey that DSPs often have difficulty communicating with adults with IDD. This communication gap not only affects the immediate quality of care but also hinders the formation of meaningful relationships between DSPs and the individuals. These challenges then often lead to heightened stress, burnout and staff turnover (Chung & Corbett, 1998), which can negatively impact the quality of care and the well-being of both the staff and the individual.

Addressing Problem behaviour in Adulthood

Therefore, addressing problem behaviour in adulthood is fundamental for decreasing risks and enhancing QoL for the individuals and those who support them (Bowring et al., 2019; Chung & Corbett, 1998). When adults can reliably communicate and express their needs, problem behaviours typically decrease while access to preferred activities and participation in community, education and employment increase (Gerow et al. 2018), which can also yield significant gains in QoL. Function-based assessment and intervention, such as

Functional Communication Training (FCT) which prioritises communication as a replacement response, skill building and environmental adaptation (Carr & Durand, 1985; Neely et al., 2018; Wacker et al. 2005), can help reducing circumstances that restrict the individuals. Crucially, adult-focused systems must implement these supports across real-world contexts (e.g., homes, day services, workplaces) to improve significant outcomes for the person (e.g., decreased frequency or intensity of problem behaviour, increased independent living skills and meaningful engagement), while reducing staff burnout and turnover by improving interactions.

Applied Behaviour Analyst (ABA)

ABA is grounded in the philosophical system of radical behaviourism, first articulated by B. F. Skinner. According to Cooper et al. (2020), ABA distinguishes itself through its focus on socially important measurable behaviour, the use of experimentation and the application of behavioural principles, to address practical issues in everyday life. Similarly, Rasmussen et al. (2022) also describe ABA as "a field of study that focuses on the application of the principles, methods, and procedures of the science of behaviour" (p. 470). In practice, ABA uses the knowledge of how behaviour is learned and maintained to improve meaningful outcomes for individuals, families and communities. For example, when behaviour analysts teach a new skill, they do not typically focus on the function of the skill itself. Instead, they identify which skills are socially important and relevant to the person's needs. Once the skill is acquired, behaviour analysts then determine the reinforcement contingencies (i.e., specific conditions where emitting a behaviour will be rewarded) and programming needed to ensure the behaviour occurs reliably across relevant environments (Durand & Carr, 1992; Wacker et al., 2005). This reflects the importance of ABA as a data-driven and socially focused approach to behaviour change, in which intervention targets are selected based on their relevance to the individual's daily functioning and QoL.

A recent meta-analysis by Virues-Ortega et al. (2022) shows that focused ABA-based procedures can produce significant effects in key areas relevant to problem behaviour and its replacement skills. Both FCT and reinforcement, in their overview, are represented in meta-analyses with large effects, which supports the claim that the function-based and reinforcement-centred interventions can reliably reduce problem behaviour while building adaptive alternatives. Further, Heward et al. (2022) supports this by illustrating the ABA's empirical reach across a very wide range of socially significant domains, including many that are adult-relevant (e.g., health, employment, ageing). Their highlights support the argument that ABA-based service delivery is not defined by a narrow set of topographies or populations, but by identifying and changing behaviour–environment relations across contexts. Results have also been reported across numerous studies, such as Kunnavatana et al. (2018), Baker et al. (2011), Bird et al., 1989 and Chezan et al. (2013), which further solidify the empirical basis for ABA-based and function-based interventions for problem behaviour in adult population.

In the context of supporting individuals with problem behaviour, ABA aims to identify the functional relationships between behaviour and environmental contingencies and to replace the problematic behaviour with a functionally equivalent and socially valid one. When providing services for problem behaviours, behaviour analysts primarily evaluate the function, rather than the form. In reality, problem behaviours that have the same topographies can actually be maintained by very different consequences (Iwata, Dorsey, et al., 1994; Northup et al., 1991). Therefore, the role of a behaviour analysts is to make these contingencies explicit through assessments, then manipulate the hypothesised variables experimentally and observe their effects on behaviour. By understanding why a behaviour persists, behaviour analysts can then design focused and least-intrusive interventions that tackle the problem behaviours.

Literature Review

Functional Analysis

What is an FA and why is it useful?

Functional Analysis (FA) is an experimental method pioneered by Iwata, Dorsey, et al. (1994) to identify the functional relations between environmental variables and problem behaviours. Unlike descriptive approaches that rely on observation and correlation, an FA is designed to demonstrate a functional relation between the behaviour and its controlling variables by systematically manipulating antecedents (i.e., what happen before the behaviour) and consequences (i.e., what happen after the behaviour) and measuring the resulting changes in behaviour (Cooper et al., 2020). It shifts the focus from "What does the behaviour look like?" to "Why is the behaviour occurring and how is it maintained over time?". Generally, FA consists of one or more test and control conditions, combined with brief and controlled scenarios to test whether a problem behaviour is reinforced (i.e., causing the behaviour to occur more frequently by providing access to the desired outcome) by specific consequences (Iwata, Dorsey, et al., 1994; Northup et al., 1991). In the test conditions, the practitioner withholds the hypothesised reinforcer (i.e., a specific thing that is rewarding for the person in the moment) until the problem behaviour occurs and reinforces the behaviour by giving immediate access to the reinforcer. This is to test whether the behaviour is functionally maintained by the specific reinforcer under the relevant establishing operation (EO) (i.e., conditions that makes a reinforcer more valuable and causes the behaviour more likely to occur to get that reinforcer). Whereas in the control conditions, the practitioner abolishes the EO by providing noncontingent access to the reinforcer. This is to test whether the behaviour decreases when motivation is low and reinforcement is freely available, thus providing a comparison between the conditions. When the occurrence of problem behaviour is high in the test condition but low in the control, it can then be concluded that the consequence

programmed in the test condition is functioning as the reinforcer for the behaviour (Iwata, Dorsey, et al., 1994; Northup et al., 1991; Sheen et al., 2024).

However, Cooper et al. (2020), Vollmer et al. (1995) and Hoffmann and Boyle (2025) highlight that FA should not be treated as a one-size-fits-all procedure, as it requires individualisation and case-to-case modification. Consequently, various FA designs (see Table 1) have been developed and refined by researchers over the years and each of them has their own strengths and is selected based on the goal of the assessment and the practical constraints of the setting. For example, Northup et al. (1991) demonstrated the feasibility of conducting a brief FA during a 90-minute outpatient evaluation by arranging short analogue conditions (i.e., approximately five to ten minutes per trial) to identify the maintaining contingency for aggressive behaviour for each participant. Also in a more recent study, Sheen et al. (2024) conducted a modified brief FA to evaluate the hoarding behaviour in a 12-year-old girl with ASD and found that her behaviour of concern was likely maintained by automatic reinforcement with a possible attention function. Using the results obtained from FA, Sheen et al. subsequently designed the treatment package, which led to rapid reductions in the behaviour of concern, with effects maintained at follow-up phase. Similarly, Bloom et al. (2011) evaluated a trial-based FA in which brief assessment trials were embedded within typical classroom routines across the day. In their comparison of trial-based and standard session-based FAs with 10 students, outcomes corresponded in six cases, with partial correspondence in the seventh, suggesting that trial-based formats can be a viable option when the resources required for a standard FA are unavailable. Therefore, in comparison with indirect and descriptive approaches, FA provides the strongest, most flexible and direct method in determining the function of the behaviour (Bloom et al., 2011; Iwata, Dorsey, et al., 1994; Northup et al., 1991; Sheen et al., 2024; Wacker et al., 1998) because it integrates information from both direct and indirect assessments, as well as manipulating the variables

Table 1

Different Types of Functional Analyses

FA Type	Design	Strengths	Limitations	Reference
Analogue	Alternates between test conditions (attention, escape, tangible, alone) with a control (play)	• Clear differentiation across functions • Gold-standard sensitivity	• Switching between conditions may produce carryover • Time consuming and staffing demands	Iwata, Dorsey, et al. (1994)
Pairwise (one control vs one test)	Compares a single test condition to a control at a time	• Suspected single function • Limited tolerance for condition switches	• Cleaner contrasts • Reduces interaction effects	Iwata, Duncan, et al. (1994)
Brief	Shortened version of analogue FA, with brief and short sessions	• Faster • Often good screening	• Lower power • Higher false negatives if behaviour is low rate	Northup et al. (1991)
Latency-based	Measures latency to first response as the dependent variable (i.e., session ends at first response)	• Safer • Useful when responses are dangerous or infrequent	• Requires precise timing • May not capture response strength	Thomason-Sassi et al. (2011)
Trial-based	Embeds very brief control and test trials into natural routines	• Contextual fit • Feasible across various settings	• May under or over-identify functions • Requires training for observers	Bloom et al. (2011)
Precursor	Targets reliable precursors instead of the dangerous topography	• Safety • Can infer function from precursors	• Must verify precursor and target correspondence • Potential generality issues	Smith & Churchill (2002)

experimentally to demonstrate the functional relation.

Gold Star Standard in Assessing Problem Behaviour

A useful way to understand "gold star standard" is to compare FA with other functional behaviour assessment approaches. Indirect assessments (e.g., interviews, rating scales) are time-efficient and can include caregivers' insights, but they are vulnerable to memory error, bias and the fact that people often presume reasons for behaviours based on the events rather than the actual contingencies (Cooper et al., 2020; Gresham et al., 2001). Descriptive assessments (e.g., ABC narrative, scatterplots) can be more objective, but they usually remain correlational, such that they show that certain events tend to precede or follow a behaviour, yet they cannot rule out any extraneous variables (e.g., task difficulty, setting events, motivating operations [MOs]) that might suggest misleading relations (Cooper et al., 2020; Gresham et al., 2001). FA, by contrast, attempts to control the variables and isolate the effect of specific contingencies by design, hence making it the strongest approach for establishing causal hypotheses about the behavioural function (Hanley et al., 2003; Iwata, Dorsey, et al., 1994). This is why FA has become a key feature of modern behavioural assessment and why its results are often treated as the most trustworthy basis for function-based intervention selection.

The evidence base for supporting FA as a gold star standard in assessing problem behaviour is relatively large for a clinical assessment technology. Decades of published research document both the vast adoption of FA procedures and their reliability to produce interpretable and differentiated outcomes, including extensions designed to improve its practicality in applied contexts (Bloom et al., 2011; Iwata, Dorsey, et al., 1994; Northup et al., 1991). Major literature reviews have catalogued hundreds of studies of individual FA outcomes over the years, showing that the methodology has been replicated across various topographies, populations and settings. For example, Hanley et al. (2003) reported

differentiated outcomes (i.e., identified function of behaviour) in 95.9% of 536 FA cases, suggesting that FAs commonly produce clear patterns that support functional interpretation. More recently, Melanson and Fahmie (2023) further strengthened the evidence base by identifying 1,333 FA outcomes from 326 studies, with 91.1% showing differentiated responding. Their review also highlights a clear trend towards efficiency and applied feasibility, including a strong shift towards shorter sessions and increased use of practical formats (e.g., trial-based, brief and latency-based FA). That said, the strongest evidence for gold star standard is not just that FAs often produce differentiated results, but that it reliably improves clinical decision-making and individualised treatment. If an assessment is identifying the core function of the problem behaviour, then interventions that match that function should outperform those that do not, as reflected in the evidence base of function-based intervention and FCT (Carr & Durand, 1985; Fisher et al., 2000; Tiger et al., 2008).

Topographical Evaluation of Problem Behaviours

The central focus of ABA is not merely what the problem behaviour looks like, but what function it serves. Topographically similar responses such as hitting, kicking or throwing objects can often be maintained by very different reinforcement contingencies across different individuals. For example, in the studies Wacker et al. (1998) and Wacker et al. (2005), “destructive” behaviour (a broad category that typically included aggression, self-injury and property destruction) was shown to be maintained by social negative reinforcement (i.e., escape from demands) for some individuals, while the same forms of aggression for others were maintained by social positive reinforcement such as access to tangibles or attention. Hence, although defining topography of the behaviours is essential for reliable measurement and comparison of response classes within a person, they do not by themselves identify the function of the behaviour.

A similar distinction between topography and function applies to hoarding-related

behaviour. In the case of hoarding, it is topographically defined as constant collecting and keeping of objects, refusal to discard non-functional items and retrieving objects from bins (Baker et al., 2011; Sheen et al., 2024), and these observable patterns of behaviour could be maintained by different or multiple contingencies across individuals. For example, the study conducted by Baker et al. (2011) showed that the hoarding behaviour of the adult participant was maintained by non-social reinforcement (i.e., automatic reinforcement). In another study conducted by Sheen et al. (2024), similar hoarding behaviour was found to be maintained by both automatic reinforcement and access to attention. Thus, the literature further highlights the importance of FAs, as the same topography of behaviour may be maintained by different consequences depending on the context, social environment and sensory outcomes associated with the response (Iwata, Dorsey, et al., 1994; Northup et al., 1991). Identifying the maintaining function is, therefore, a crucial component of treatment design.

Function-based Intervention Supports

What is Function-based Intervention Support?

Function-based supports are a category of assessment-driven interventions that aim to reduce problem behaviour by addressing the reason it occurs. Rather than attempting to suppress the behaviour through aversive consequences or one-size-fits-all programmes, they adjust the individual's environment and teach skills that are tailored to the purpose of the targeted problem behaviour (Austin & Tiger, 2015; Sheen et al., 2024; Snyder et al., 2024). In fact, from a behaviour-analytic perspective, behaviour is shaped by its consequences and the contexts in which it occurs (Iwata, Dorsey, et al., 1994; Northup et al., 1991). For instance, if a student shouts to gain the teacher's attention, removing them from class may not reduce their problem behaviour, but instead it leaves their attention need unmet. Conversely, giving attention after the shout may strengthen their attention-maintained behaviour. Therefore, function-based interventions prevent such errors by targeting the function of the behaviour

and teaching a replacement behaviour that produces the same outcome as the problem behaviour (Austin & Tiger, 2015; Carr & Durand, 1985; Tiger et al., 2008).

An effective function-based support begins with a Functional Behaviour Assessment (FBA). This typically includes implementing indirect methods (e.g., interviews, rating scales) (Hanley, 2009) that involve caregivers, teachers or support staff to obtain preliminary information that helps to generate hypotheses about the functions of the problem behaviour. Followed by direct observations (e.g., Antecedent-Behaviour-Consequence recording, continuous measurement) (Gresham et al., 2001) to establish the reliable patterns of the behaviour. When safety and resources allow, an FA can then be set up to test different conditions and identify the contingencies that are maintaining the behaviour by experimentally manipulating the antecedents, consequences and environment (Deochand et al., 2020).

Functional Communication Training

Instead of treating problem behaviour as an expression of internal states, ABA sees it as an observable operant behaviour that is maintained by its consequences or through interactions with environment. When an individual is unable to express themselves in a conventional way, such as vocal speech, they tend to exhibit some form of alternative behaviour to get what they need and want (Carr & Durand, 1985; Wacker et al., 1998; Wacker et al., 2005). This includes problem behaviours such as verbal aggression (e.g., the use of disrespectful or reprimanding language), physical aggression (e.g., acts of property destruction or physical attacks on people around) or more intense forms such as tantrums or self-injury, which can often cause disruptions and pose safety risks to the individual and those around (Chung & Corbett, 1998; Hensel et al., 2011).

FCT, a differential reinforcement procedure (Carr & Durand, 1985; Tiger et al., 2008), is a behavioural intervention strategy that emerged from decades of work in ABA that

is based on the concept of FBA. It is specifically designed to replace problem behaviours with functional communication responses (FCR) (i.e., an alternative communication method used to produce the same outcome as the problem behaviour) that are appropriate and socially acceptable (Carr & Durand, 1985). Over the years, FCT is widely recognized as one of the most empirically supported behavioural interventions for reducing problem behaviours in individuals with DDs (Fisher et al. 2000; Neely et al., 2018; Tiger et al., 2008). The earliest empirical support for FCT research done by Carr and Durand (1985) demonstrated that problem behaviour can be replaced with the equivalent FCR and it effectively reduced escape-maintained and attention-maintained behaviours in individuals with DDs. Since then, many research and studies have been conducted (e.g., Bird et al., 1989; Chezan et al., 2013; Wacker et al., 1998; Wacker et al., 2005) to examine the effectiveness of FCT in reducing problem behaviours and acquisition of appropriate communicative alternatives across various settings, ages, populations and communication mode (Heath et al., 2015).

One of FCT's greatest strengths is its high degree of individualisation. Its compatibility with speech and a range of AAC modalities makes it suitable for implementation across various ability levels and settings (Heath et al., 2015). More importantly, it can be customised to an individual's unique needs and abilities across a wide age range, from children (Sigafoos et al., 2018) to adults (Kunnavatana et al., 2018). Furthermore, it is also worth noting its adaptability to various naturalistic settings, such as schools (Walker et al., 2018), clinics (Sigafoos et al., 2018) and homes (Wacker et al., 1998; Wacker et al., 2011), without compromising its effectiveness. FCT also offers benefits that extend well beyond the immediate reduction of problem behaviour. Once an individual has mastered the FCR, this training further ensures that the skill generalises to different settings, materials, activities and communication partners. As a result, the individual can better express their needs and wants directly rather than having others to guess, thus yielding practical gains

for caregivers and service systems (e.g., reduced stress, fewer restrictive practices, clearer routines) and long-term benefits for individuals (e.g., reduced problem behaviour, increased choice and control, improved QoL) (Durand & Carr, 1992; Neely et al., 2018).

Early demonstrations of FCT with adults showed that the core logic of the procedure generalises to long-standing and high-risk behaviour in residential services. For example, Bird et al. (1989) used FCT to replace severe aggression and self-injury behaviour in two adult men with IDDs living in community residences. Following a functional assessment, the authors taught simple FCR that produced the same social consequences as the target behaviour to the participants. The result of the study reported large and durable reductions in problem behaviours after years of less successful approaches, with generalisation across staff, settings and increasing task demands. Subsequent work by Chezan et al. (2013) which evaluated a discrete-trial FA followed by FCT for three adults with IDD and problem behaviour in a vocational setting. They reported a clear identification of behavioural functions, successful acquisition and discriminated use of FCRs for all participants, illustrating that the FCT interventions are viable even in adult day programmes. Further, Ghaemmaghami et al. (2016) highlighted that the effectiveness of FCT depends not only on the acquisition of an FCR but also on whether the treatment can be extended to contexts that involve unavoidable and unpredictable delays to reinforcement, as these delays can often produce loss of the FCR and resurgence of problem behaviour if not programmed carefully.

Functional Communication Response

An FCR is a functionally-matched and teachable method for an individual to communicate that produces the same outcome as their problem behaviour. It can be any clear and efficient method (e.g., vocal speech, gestures, manual sign, picture exchange) that helps the individuals to get their desired result (Frolli et al., 2022; Sigafoos et al., 2018; Tincani, 2004). The reason FCR is effective is because they alter the contingency structure while

preserving the function of the problem behaviour. Instead of eliminating the reinforcement, individuals are taught using differential reinforcement to replace problem behaviour with a low-effort and high-payoff communicative method. To successfully replace the problem behaviour with an FCR, the new response must be: (a) efficient (rapid and low effort), (b) understood by communication partners and (c) consistently reinforced, especially in early phases (Carnett et al., 2019; Carr & Durand, 1985; Ringdahl et al., 2018). In addition, Carnett et al. (2025) also demonstrated that individuals can rapidly acquire a mand (i.e., demand, request, ask for something) response to mastery with their preferred modality. Although a poorly chosen FCR may still reduce behaviour, it can be unreliable and does not promote consistent use in practical contexts, particularly when reinforcement is thinned.

Augmentative and Alternative Communication

AAC refers to the tools, strategies and systems that support or replace spoken communication, such that "augmentative" means adding to speech and "alternative" means replacing speech when it is unreliable or absent. These systems are designed to provide support to individuals who have trouble using conventional forms of communication (i.e., vocal speech) and is implementable across various contexts (e.g., home, school, work, community settings) which subsequently reduce the occurrence of problem behaviour (Carnett et al., 2019; Schlosser & Sigafoos, 2006). They can be customised to the individual's cognitive, motor and sensory capabilities that aids a non-vocal person to express what they want, to whom they want and when they want (American Speech-Language-Hearing Association, n.d.). AAC modalities range from unaided (using physical body, e.g. facial expression, body language, gestures or signing) to aided systems (using external tools to communicate, e.g. Picture Exchange Communication System [PECS], Speech Generating Devices [SGD], iPad, Voice Output Communication Aids [VOCAs]). Although one modality has advantages over the other, both Tincani (2004) and Frolli et al. (2022) suggested that FCT

should always be individualised rather than “one-size-fits-all” as there is no single system that suits everyone or every context, for each individual has their own preference and motor capabilities.

Looking at the available literature, many FCT studies have implemented AAC modalities as an FCR to reduce problem behaviour in children (Charlop-Christy et al., 2002; Mirenda, 1997; Walker et al., 2021) but similar studies in adult population are scarce and remain an important area for research. These available studies in children population have shown that embedding AAC system within FCT can effectively reduce problem behaviour while promoting the consistent use of the FCR. For example, Walker et al. (2021) used low-tech aided AAC (i.e., picture communication symbol) as FCR across all three participants diagnosed with DDs to reduce their problem behaviour in school settings. The value of AAC in this case here was not simply that an FCR was “added”, but functioned as a standardised response form that optimises the communicative pathway for the individuals. Similarly, Charlop-Christy et al. (2002) evaluated the PECS across their participants. Their finding is consistent with the concept of FCT, such that when a clear, efficient and reinforced FCR is established, the MOs (i.e., an environmental variable that alters the value of a reinforcer) that previously triggered problem behaviour may instead prompt the person to use the FCR to communicate. Therefore when speech is absent, inconsistent, not sufficiently intelligible or fluent to contact reinforcement quickly in natural contexts, AAC-based response provides the practical means to allow the individuals to express their needs and wants, hence engagement in problem behaviour becomes unnecessary.

Importance of AAC Evaluation

Systematic evaluation of AAC modality is an ethical and clinical necessity (Carnett et al., 2019). Selecting which modality to act as FCR to replace problem behaviour is crucial, as the choice can directly affect the acquisition speed, independence, durability under schedule

changes, generalisation and social validity. When the proposed modality does not fit the user's profile or preferences, the system becomes effortful or simply unusable and hence the resurgence of problem behaviour (Carnett et al., 2019; Couper et al., 2014; Ringdahl et al. 2018; Torelli et al., 2016). That said, selecting an appropriate modality requires pinpointing the features that are most important and suitable for the individuals, thereby promoting reliable and consistent use of the AAC system (Allen et al., 2023; Carnett et al., 2019; Carnett et al., 2025; Torelli et al., 2016) to reduce problem behaviour. Furthermore, most high-tech AAC materials can be expensive to own and maintain. And even for low-tech options, such assessment also helps to prevent wasted effort and cost, as Allen et al. (2023) reported that up to 33% of the users are often found to abandon their system once novelty wears off or when practical issues arise (e.g., material durability and portability, evolving needs, feature-need mismatch). Therefore, thorough matching of modality to the individual's needs is essential to ensure that funding or effort are invested in systems that are likely to be used appropriately.

In terms of mand topography preference, determining the individual's preferred modality may also contribute to sustaining the long-term use. While different modalities can produce the same outcome, an individual may prefer one modality over the other and may directly impact the rate of acquisition and independent responding (Kunnavatana, 2018; Ringdahl et al., 2018). That being said, a modality that the individual prefers can promote self-determination (van der Meer et al., 2012), better maintenance of use and reduces instances of problem behaviour (Carnett et al., 2019; Carnett et al., 2025; Couper et al., 2014; Ringdahl et al., 2018; Torelli et al., 2016). Therefore, conducting a mand modality assessment (MMA) prior to FCT to identify the individual's preferred modality is crucial in ensuring personalised treatment and supporting long-term sustainability of functional communication (Carnett et al., 2019).

Delay and Denial

Delay and denial are everyday experiences, but they are also precise behavioural contingencies with profound effects on learning, self-regulation and social participation. For example, we queue up to wait for our turn at restaurant, or we are told “no” when something is unavailable. Yet many individuals find these moments difficult to accept. In ABA, delay typically refers to a temporal gap between an emitted FCR and the delivery of reinforcer (Austin & Tiger, 2015; Hagopian et al., 2005), whereas denial refers to the refusal of access to a reinforcer (Edelstein et al., 2021; Snyder et al., 2024). While the two may look similar to the person on the receiving end (i.e., “I asked and I didn’t get it”), they are functionally different in terms of behavioural functions. Through delay-and-denial tolerance training (DDTT), a person can be taught to tolerate delay and accept denial to reduce the likelihood that their behaviour escalates into problematic behaviour. This training prepares the individual for real-life contingencies as natural contexts rarely offers immediate and guaranteed reinforcement (e.g., academic achievement, career progression).

Within the FCT literature on DDTT, MMA represents a novel addition whereby a preference assessment is conducted before the training, prioritising the most preferred modality as the mand response throughout the process. This sequencing may strengthen the treatment effects by increasing the likelihood of immediate and independent manding, while supporting the persistence of appropriate communication (Carnett et al., 2019; Carnett et al., 2025) when reinforcement is delayed or unavailable. Once the preferred modality is identified and the individual demonstrates proficiency with the targeted FCR and shows a consistent use of the skill (Austin & Tiger, 2015; Hagopian et al., 2005), thinning of reinforcement schedule is then introduced to the tolerance training by gradually increasing the delays after the emission of FCR. However, these approaches often result in the increase of problem behaviour or disruption of the communicative response as delays grew,

highlighting the fragility of newly taught FCRs under thinned schedules. Recognising this, Hagopian et al. (2005) and Austin and Tiger (2015) evaluated the effect of competing stimuli (i.e., stimuli identified as producing reinforcement that is functionally equivalent to the reinforcer maintaining the problem behaviour) in their studies to test whether they would stabilise the occurrence of problem behaviour during DDTT where the reinforcement schedules were thinned while keeping the FCR intact. Their findings demonstrated that competing stimuli can be used during delay of the reinforcement in trainings or even in naturalistic settings to promote tolerance to waiting and reduce escalation of problem behaviour.

Following the teaching of delay tolerance, DDTT also teaches the individual to accept explicit unavailability of the requested reinforcer while placing problem behaviour on extinction systematically (Edelstein et al., 2021; Snyder et al., 2024). The aim is to strengthen the durable coping with real-world unavailability while preventing relapse of problem behaviour when the desired reinforcers are unavailable temporarily or permanently. Although this training has historically been less frequently evaluated than delay tolerance, recent studies by Edelstein et al. (2021) and Snyder et al. (2024) indicated that teaching appropriate responses to “no” contingencies, especially when paired with access to alternative reinforcement, can reduce problem behaviour and support adaptive participation. This highlights the function of the alternative as a competing source of reinforcement during denial, thereby reducing the MOs for the denied reinforcer and making the denial period more tolerable. In other words, the individual is not left without reinforcement altogether but is instead taught with a “what to do instead” response pattern.

As reinforcement becomes less immediate during DDTT, one common risk is that the individual may begin to abandon the FCR and re-engage in problem behaviour or inefficient communication because the contingency is no longer clear (Durand & Carr, 1992; Wacker et

al., 2011). One way to mitigate this is to programme cues that signal the individual when reinforcement is available versus when a delay or denial is in effect, thus turning the procedure effectively into a discriminated schedule with predictable conditions. Brown and Nercesian (2024) utilised discriminative stimuli (S^D) (i.e., an antecedent cue that signals reinforcement is available for a specific behaviour) as a practical way to make delay tolerance training work like a discriminated schedule rather than a prolonged period of uncertainty where emission of FCR does not contact reinforcement reliably. The point is to maintain appropriate and efficient communication as reinforcement becomes less immediate or less frequent. Their findings show that adding S^D can reduce ambiguity about contingency changes and therefore promote functional communication.

Importance of Delay and Denial Tolerance Training

The ultimate goal of FCT is to replace problem behaviour with a functionally equivalent FCR, so the value of the intervention is tightly linked to whether the effects last beyond the teaching context (Austin & Tiger, 2015; Snyder et al., 2024; Tiger et al., 2008). For instance, if the FCR learned only occurs when the therapist is present, when reinforcement is perfectly delivered or when conditions are highly structured, the intervention therefore has limited real-world impact. That said, lasting effects mean the individual continues to use the FCR instead of problem behaviour across everyday routines, people and settings, thus promoting a safer, more independent and more socially meaningful behaviour change (Snyder et al., 2024; Tiger et al., 2008). One of the major reasons why durability of the use of FCR can weaken or fail is that everyday environments rarely provide immediate and guaranteed reinforcement for appropriate communication (Brown & Nercesian, 2024). In fact, natural contingencies routinely include delay and denial, and these conditions can quickly re-establish problem behaviour if the individual has not been taught what to do when the FCR does not contact reinforcement as expected.

DDTT also matters because it addresses a common maintaining variable for escalation, specifically the reinforcement delivered following problem behaviour (Fisher et al., 2000; Ghaemmaghami et al., 2016; Hagopian et al., 2005). Many individuals have experienced a learning pattern where mild problem behaviour does not produce reinforcement, but severe behaviour does, and that learning history strengthens persistence and intensity (Ringdahl et al., 2018; Wacker et al., 2011). For instance, when the individual occasionally gains access to reinforcement after a long tantrum, longer tantrums may be more likely in future because persistence has been reinforced. It is crucial to recognise that, in the absence of a reinforced alternative response, individuals tend to allocate behaviour towards responses that are more efficient in producing reinforcement or terminating aversive conditions (Carr & Durand, 1985; Horner & Day, 1991; Tiger et al., 2008). Therefore, DDTT reduces the risk by planning structured exposure to the contingencies while reinforcing tolerance to prevent the individual from learning that escalation of problem behaviour is the most efficient method (Austin & Tiger, 2015; Edelstein et al., 2021; Fisher et al., 2000; Hagopian et al., 2005). Over time, treatment can shift responding towards the more practical and humane option, supporting durability of effects and reducing the likelihood that escalation continues to be reinforced.

Current Study

The current study aimed to replicate previous research (Kunnavatana et al., 2018) by evaluating, with adult participants, the effectiveness of a preferred mand topography that was identified following the differential training of two AAC modalities. Specifically, it examined the extent to which this preferred mand response would demonstrate a faster acquisition rate when it is used as a function-based replacement for problem behaviour, thus producing clinically meaningful reductions in problematic behaviour when an individually preferred communication response was available. The study was then extended by implementing the

preferred AAC modality as the primary mand response within a function-based intervention and involved assessing generalisation of the response in naturalistic environments, as well as evaluating the participant's performance during DDTT, in which access to reinforcement was systematically delayed or withheld.

Method

Ethics Approval and Consent

This research project received ethics approval from the University of Waikato Human Research Ethics Committee [HREC(Health)2024#75]. We then held an online meeting with the participating family to outline the study's aims and potential benefits for the participant's future communication development, while addressing all questions prior to obtaining informed consent.

Recruitment and Inclusion Criteria

The participant was recruited via referral from a psychologist who worked at a local residential support organisation in New Zealand. Inclusion criteria were participants who: (a) aged 18 years or older; (b) had a diagnosis of a developmental disabilities; (c) had limited speech production; and (d) engaged in problem behaviour that directly restricted their participation in daily life.

Researchers

This thesis research was a part of a larger on-going project led by Dr. Amarie Carnett, a doctorate-level, Board-Certified Behaviour Analyst (BCBA-D). I was the primary researcher for this thesis and conduct all of the research sessions, analysed the data for the participant involved in this sub-project. Before the project commenced, I had completed all required courses and gained the required knowledge to contribute to the study.

Participant and Settings

Leon (pseudonym) was a 25-year-old, New Zealander-Japanese male with a clinical diagnosis of ASD and ID. Leon presented also with a visual impairment, that his left eye blind following a retinal detachment, and his right eye was affected by astigmatism and short-sightedness which he wore corrective lenses to support. Based on the input from his parents,

he could understand both English and Japanese language, although he was non-verbal (non-speaking). Prior to the enrolment in the research, his parents reported he was not consistently using a communication system and had difficulty conveying his basic wants and needs, although he had prior exposure to some sign language and picture-book communication system that had been used when he attended school. This system included basic requests (e.g., activities, numbers, foods, colours) and general communication symbols (e.g., yes, no, I want).

At the time of the study, Leon was living in his family home, which included his mum and dad. According to the parents, his problem behaviour of taking (and sometimes hiding) items that did not belong to him, without permission, often led to others losing their belongings, caused distress to people around and interfered with his community participation since his parents and support staff would often have to avoid bringing him to shops that contained preferred items. When the parents or support staff attempted to take the items away from him, his behaviour would escalate into aggression, and he would physically block them from reaching the items or when the item was retrieved, he would throw or break his glasses in response. As Leon had a relatively large body size, his parents and support staff often had troubles retrieving items and calming him down when his aggression escalated. As such, Leon met all study inclusion criteria and participated in the study after informed consent was obtained.

All sessions were conducted face-to-face in two settings: in a conference or activity room at the community centre and in Leon's home, to ensure meaningful environments were incorporated into the project. Prior to every session, the room was arranged to contain the relevant materials (i.e., preferred stimuli, data recording items) that were required for the session. Home sessions took place at the living room, and unnecessary items were removed before every session. Although sessions took place within the living room, Leon still had

access other areas in the house (e.g., kitchen, bathroom) and the stimuli within those spaces.

Materials and Equipment

Video Recording Equipment

Sessions were video recorded for data collection and coding purposes. To protect confidentiality, all data and videos were stored in the password-protected cloud storage and removed from the recording device after each session.

Time Tracking Equipment

A digital timer was used in FCT keep track of the delay interval and reinforcement duration.

Functional Communication Modalities

Two sign images were sourced from the New Zealand Sign Language (NZSL) Dictionary and the vocabulary sheet was printed and laminated for use in the assessments.

A grid-based picture system used was used as a low tech Aided-AAC option. This system included a laminated picture grid system that containing pictures and corresponding word labels above each item. The layout was arranged similarly to Leon's previously used picture communication book to promote familiarity when requesting for an activity or item (e.g., "I", "Want", "Sensory Items"). The sheet was subsequently incorporated into Leon's new picture communication binder. Although Leon had previous experience with sign language and picture book communication, he had not been exposed to the new signs and new picture symbols for the tangible items that were identified when evaluating Leon's problem behaviour.

Sensory Items /Art Materials

The sensory items included shiny metallic objects and squishable items in the form of animals, foods or shapeshifters that provide sensory input. The art materials consisted of

items that mainly used for arts and crafts (e.g., colouring pencils, pens, tape, paper). These items were placed in separate boxes for easy access and clear differentiation.

Data Collection Forms

Different data collection forms were created for the various assessments and phases of intervention in the research project.

For the indirect assessments, the Open-Ended Functional Assessment Interview (Hanley, 2009) was used to gather information about Leon and his behaviour of concern from relevant parties via interviews. The assessment interview comprised of 20 core questions covering background information, individual preferences, antecedent and consequence conditions and the problem behaviour's topographies and severity. Data from the Open-Ended Functional Assessment Interview (FAI) indicated that Leon was most likely to take highly preferred or novel items such as art and craft supplies (e.g., pens, tape, markers), visually shiny or sensory items (e.g., ornaments, fidgets, squishy toys).

A questionnaire for the indirect mand modalities assessment (MMA) was also used to determine the potential communication modalities to be directly assessed. This questionnaire included questions about learner's ability, existing communication repertoire, motor skills, learning history and communication preference (Carnett et al., 2025). Data from the indirect-MMA indicated that the viable mand modalities for direct assessment were sign and a picture-based selection system.

For the FA, MMA and intervention phases, data sheets all included a space for observers to record session information (e.g., date, observer name, participant's name) and included tables for recording data. The dependent and independent variables were pre-printed on the datasheet for observers to circle the appropriate code following each occurrence of the behaviour. Fidelity checklists were also included on the datasheets to enable the second observer to record data while monitoring the procedural integrity.

Topographical Definition of Precursor and Problem Behaviour

The topography of precursor behaviour was defined as Leon attempting to leave his initial position and reach to the items that did not belong to him when permission had not been gained. Whereas, the topography of problem behaviour was defined as taking and hiding items that did not belong to him when permission had not been gained and moving it to a non-visible locations (e.g., his clothing pocket, backpack, under furniture, etc.) or semi-visible locations (e.g., sit on it, tuck into the laps, use paper to cover, etc.), so it cannot easily be seen without opening or moving something.

Research Design

A two phases assessment was used to evaluate the function of behaviour. For Phase 1, the research began by conducting indirect assessment using Hanley's Open-Ended FAI (Hanley, 2009) with the parents to obtain preliminary information about Leon and his behaviour of concern. For phase 2, an experimental brief FA (Northup et al., 1991) was conducted to evaluate occurrences of problem behaviour across test and control conditions (Kunnavatana et al., 2018), which subsequently guided the design of the treatment that followed.

Once the function was identified, a two-phase MMA was conducted to identify a communication mode for the treatment phase. During Phase 1, an indirect assessment was used to identify possible modality options to be evaluated. For Phase 2, an experimental MMA was conducted in the context of FCT (Carnett et al., 2025; Ringdahl et al., 2018) to briefly assess the efficiency in replacing Leon's problem behaviour with an FCR and to determine his preference between the two different AAC modalities, to be used within subsequent treatment phases.

Throughout all FCT phases, only the preferred modality identified (picture communication) during the MMA was used. Treatment effectiveness was evaluated using a

multi-phase single case design across behaviours. The FCT intervention consisted of four phases (Edelstein et al., 2021; Ghaemmaghami et al., 2016; Snyder et al., 2024) aimed at replacing Leon's problem behaviour and promoting the durability of the FCR. In Phase 1, Leon was taught how to use the preferred modality identified in the MMA phase as the FCR to request for the items associated to his problem behaviour independently. In Phase 2, Leon was further taught, in a naturalistic context, to take only the items corresponding to his FCR request. In Phase 3, delayed reinforcement schedules were introduced to strengthen his tolerance for waiting for reinforcement until predetermined terminal delay was achieved. Lastly in Phase 4, denial of reinforcement training procedure was implemented to increase his tolerance for occasions in which access to the preferred item was unavailable.

Response Measurement

Functional Analysis

During the FA, data were collected on the frequency of problem behaviour (i.e., the number of items hid per session) and emission of independent AAC-based FCR in each condition.

MMA

During the MMA (direct assessment), data were collected on the independent and prompted mand responses for two different AAC modalities. For picture communication, independent response was defined as instances when Leon touched the picture on the picture communication sheet using his index finger to indicate a request for either of the selected item. For sign language, independent response was defined as accurately (or close proximity) shaping his hands to make sign for an item. The sign for "sensory item" was a C-shaped hand with the palm facing downwards and wobbling grasping motions, and the sign for art materials was extending the left-hand palm flat and upward facing, with the right-hand index finger slightly more extended than the other fingers. The right index finger then traces a short

and curvy line in a controlled motion (as if drawing on a page.). Responses were coded as independent for both modalities if Leon emitted the mand within 10s of the manipulation of the establishing operation (EO). For prompted mand responses, they were scored if the researcher provided a model, vocal, gestural or partial physical prompt was used to evoke the mand. Additionally, instances of precursor behaviour and problem behaviour were also collected during these sessions. Independent picture based and sign-based response percentages were calculated by dividing the number of trials in which Leon independently emitted the AAC-based FCR by the total number of trials per session.

Functional Communication Training

Phase 1. Similar to the MMA, data were collected on independent and prompted mand responses (FCR) using the picture-based mode, such that they were scored as independent or prompted depending on whether Leon responded with or without assistance. Additionally, precursor behaviour was scored in instances where Leon attempted to retrieve items (e.g., walking in the direction of the items, reaching towards the location of the items) either without emitting the FCR or without waiting for confirmation from the researcher to retrieve the item corresponding item and was redirected when given a verbal reminder. Problem behaviour was coded when Leon took an item without emitting the mand response or without waiting for confirmation from the researcher to retrieve the corresponding item, since this behaviour was within the response chain for hiding highly preferred items.

Phase 2. Similar to Phase 1, data were collected on mand responses (FCR) using the picture communication modality, item correspondence, as well as precursor and problem behaviour. Following an independent mand, item correspondence was scored as correct when Leon selected items that corresponded with the picture card. All non-corresponding selections were scored as incorrect, and a brief corrective verbal statement and model prompt was provided. Percentage for mands with correspondence were calculated by dividing the number

of trials in which Leon picked the item corresponded to his selection by the total number of trials per session.

Phase 3. Similar to Phase 2, data were collected on the occurrences of precursor and problem behaviour, mand responses (FCR) and the addition of tolerance responses. A tolerance response consisted of Leon responding to the researcher after being told he needed to wait, after he emitted a mand for a preferred item. This response involved Leon emitting a "thumbs up" gesture towards the researcher. Tolerance response percentages were calculated by dividing the total number of delayed trials in which Leon engaged the tolerance response with absence of either precursor or problem behaviour by the number of wait trials per session.

Phase 4. Data collection was similar to Phase 3, except for the addition of denial trials. For tolerance responses, the percentages were calculated by dividing the total number of delayed and denial trials in which Leon engaged in either precursor or problem behaviour by the number of trials per session.

Interobserver Agreement (IOA) and Procedural Integrity

A second independent observer scored IOA and procedural integrity across all phases. To facilitate this, a simple table listing observable procedural steps was attached to each data sheet, allowing real-time scoring while monitoring treatment fidelity across sessions. In cases where the second observer was not available to observe in-vivo, sessions were video recorded and uploaded to the cloud storage so that the observer could code from the recordings. Throughout the study, IOA and procedural integrity was calculated for 44.44% of FA sessions, 58.33% of MMA sessions, 40% of preference assessment sessions, 55.56% of FCT Phase 1, 57.14% of Phase 2, 43.75% of Phase 3 and 50% of Phase 4. Subsequently, IOA for each phase was calculated by dividing the number of agreements by the total number of agreements plus disagreements for the session and multiplying by 100%, while procedural

integrity was calculated by dividing the number of correctly implemented procedures by the total number of procedures and multiplying by 100%. The mean IOA obtained was 91.67% for FA, 82.86% for MMA, 100% for modality preference assessment, 100% for FCT Phase 1, 90.67% for Phase 2, 99.05% for Phase 3 and 98% for Phase 4. Whereas the mean of procedural integrity was 100% for FA, 80% for MMA, 100% for modality preference assessment, 97.71% for FCT Phase 1, 100% for Phase 2, 99.37% for Phase 3 and 100% for Phase 4.

Procedures

Indirect Assessment of Problem Behaviour

At the beginning of the study, Leon's parents and support staffs were interviewed using Hanley's Open-Ended FAI to gain a better understanding of Leon's behaviour and how it affects those around. The questions in the assessment include: (a) background information (b) identifying a target behaviour and the potential risks involved; (c) determining the antecedents that are likely to evoke the problem behaviour; and (d) identifying the consequences that are reinforcing or maintaining the occurrence of behaviour. Questions were asked in a semi-structured format and, based on the parent's responses, follow-up questions were asked during the interview to obtain further information (e.g., "what do you think he's doing that behaviour for?", "are there any particular items that he likes hiding?", "what songs does he like?", etc.). Based on the finding from the FAI, FA procedures were developed to directly assess the problem behaviour.

Functional Analysis

Following the outcome of the indirect assessment, a modified brief FA (Iwata, Dorsey, et al., 1994; Sheen et al., 2024) was conducted for Leon. Given the nature of the problem behaviour, the conditions tested included the following combined functions: attention-tangible, alone-tangible and leisure-tangible in a multielement design. Three 5-minute

sessions were conducted for each condition, with short breaks between them. The sequence was randomised, but no condition was tested more than twice consecutively. All FA data were recorded using the available datasheet.

Attention-tangible Condition. During the attention condition, the room was arranged with targeted items (i.e., sensory items and art crafting materials) that were placed randomly around the room but positioned within Leon's reach. The researchers were both present in the room and maintained a close distance with the participant. At the start of the session, the researchers stated they had to discuss something and Leon was allowed to play around with the highly preferred items within the room. Both researchers then withdrew their attention. Contingent upon occurrence of problem behaviour, the researchers delivered a brief attention and said, "Yes, you can have that." All other behaviours were ignored.

Alone-tangible Condition. In the alone condition, a camera was positioned in the room to record video and targeted items were placed randomly around the room. Then, Leon was left alone in the room while the researchers waited outside the room. After each session, researchers reviewed the recordings to code instances of Leon's targeted problem behaviour.

Leisure-tangible (Control) Condition. For the leisure condition, a camera was also positioned in the room to record the sessions and targeted items were placed randomly around the room. During the sessions, the researchers played Leon's favourite songs and invited him to dance to the music. No demands were placed on Leon, attention was provided by giving him a thumbs-up every 30 seconds and he had free access to all preferred items. There were also no programmed consequences for any of his problem behaviour and the researchers coded instances of Leon's problem behaviour from the recordings after each session.

Indirect Mand Modality Assessment

After the function was identified, the researcher arranged a brief face-to-face meeting with the parents to identify at least two AAC modalities that might be suitable options for

Leon. This assessment consisted of a decision-making framework and questions to help guide a conversation around modality options, learning history and communication preferences for Leon.

MMA-FCT Phase

After the potential modalities had been identified through interviewing the parents, a response acquisition phase embedded into FCT was further conducted to teach Leon in using the two modalities. The activities that had been identified previously in FA (i.e., sensory items and art crafting materials) were used as the targeted novel items in this phase. A multielement design was implemented, in which each modality was paired with both activities. This yielded a total of 12 sessions that were conducted in quasi-randomised order, with none of the pairings tested more than two times in a row. During sessions, materials were positioned in Leon's view but out of reach, while AAC systems were kept within reach. When he indicated his interest in or attempted to reach for a particular item, graduated guidance prompting was used to establish the mand response (see Table 2) with the AAC system. Each time Leon emitted a correct mand response, he was given access to the corresponding item for approximately 30 seconds.

Choice-Probe Sessions

Once the response acquisition phase was completed, choice-probe sessions were conducted to identify which communication modality Leon preferred by allowing him to mand for either activity. During the sessions, Leon was seated across a table, with two boxes containing his preferred items placed within sight but out of reach. A verbal S^D, "If you need anything, you can tell me using either the picture card or sign", then placed the picture communication card on the table while holding the laminated sign language visual image sheet in hand and in Leon's line of sight. Contingent on Leon emitting a mand using either modality, he was granted a brief access (30 seconds) to the corresponding activity. If Leon

Table 2

Prompting Description for AAC Modalities

	Prompts	Picture Communication	Manual Sign
Least ↓ Most	Independent	Leon touched the picture on the picture communication sheet using index finger to mand	Leon shaped his hands and used proper movement to sign for "sensory items" or "art materials"
	Gestural	We pointed at the picture communication sheet in front of Leon to cue the target response, without any physical contact	We pointed at the NZSL vocab sheet in front of Leon to cue the target response, without any physical contact
	Vocal/Model	We either gave a spoken cue or pointed on the corresponding image for Leon to imitate	We either provided a verbal prompt or physically demonstrated the manual sign for Leon to imitate
	Partial Physical	We grabbed Leon's hand, moved it towards the picture card and immediately released it once movement began	We briefly adjusted Leon's handshape and immediately released contact as he completed the sign independently

did not emit a responses within approximately five seconds, the items in the boxes were represented and the verbal S^D was provided again.

Functional Communication Training

Baseline. Data was extracted from the FA session, such that we only used the data for problem behaviour in alone-tangible condition because it was identified as the maintaining contingencies for Leon's problem behaviour. Also, occurrences of Leon's independent emission of targeted FCR across the FA sessions was coded from the recordings.

Phase 1 FCT Acquisition. Following the MMA-FCT phase, the results of the MMA were discussed with Leon's parents. After reviewing the data, they agreed to select the AAC

mode that Leon showed proficiency and most frequently chose during the preference probes. Leon's preferred AAC modality was used within the context of FCT to ensure acquisition of the targeted FCR. Sessions were conducted similarly to the previous phase and across multiple days, with each consisting of five trials and lasting approximately 15 to 20 minutes. FCT sessions included the presentation of the items associated to Leon's problem behaviour (i.e., sensory items and art supplied) and preferred AAC modality used to engage in the target request. The sessions began by positioning of the communication card on the table, within Leon's reach, and said, "Here's your picture sheet in case you need to ask for anything," while pointing at the sheet. Upon indication of his interest in gaining access or attempted to reach for the items, graduated guidance prompting was used to establish the targeted request (Ghaemmaghami et al., 2016) (see Table 3). Every time an FCR was emitted, we placed the box of items on the table and gave him the access to the preferred items for approximately 30 seconds. On rare occasions, Leon pointed to other pictures on the sheet (e.g., dominoes, sand, Numicon) and we quickly responded, "Sorry, I don't have that with me." During training sessions at home, Leon occasionally engaged in other activities (e.g., making tea, eating a sandwich, using the toilet, etc.), thus inter-trial times would fluctuate as needed. During

Table 3

Prompting Description for FCT Phase 1

	Prompts	Picture Communication
Most ↓	Vocal/Model	Providing vocal directions or pointing on the corresponding image for Leon to imitate while saying, "Touch this for [activity name]."
	Gestural	Pointing at the picture communication sheet in front of Leon to cue the target response, without any physical contact or verbal prompts.
Least	Independent (no prompt)	Leon touched the picture on the picture communication sheet using index finger to mand.

sessions at the centre, he sometimes requested for snacks or took part in other training with the psychologist as part of the break.

Phase 2 Naturalistic FCT. In this phase, we added a third box containing a mixture of sensory items and craft materials arranged in various locations around the room to simulate how stimuli are arranged in Leo's naturalistic environment. Session began by placing the three boxes far from Leon around the room at various locations. As in Phase 1, the communication sheet was positioned on the table within Leon's reach, and the researcher said, "Here's your picture sheet. Let me know if you need anything." Once Leon emitted the targeted FCR, we said, "Yes, you may go get the items" and allowed him to go to the box and select the items that he wanted. In cases where Leon engaged in precursor behaviour (i.e., walked to the boxes without emitting any FCR), a verbal redirection was provided, "These are not yours. You need to ask," and handed him the picture sheet. If he did not respond, we implemented a least-to-most prompting strategy (see Table 4), increasing the prompt level every three seconds. On occasions when Leon chose an activity but the items selected from the box did not correspond with his mand (e.g., chose an art activity but picked sensory items), an error correction was provided by saying, "Those aren't the items you chose," and

Table 4

Least-to-Most Prompting Hierarchy for FCT Phase 2

	Prompts	Picture Communication
Least ↓ Most	Independent	Leon touched the picture on the picture communication sheet using index finger to mand.
	Gestural	We pointed at the picture communication sheet in front of Leon to cue the target response, without any physical contact or verbal cue.
	Vocal/Model	We gave a spoken cue or pointed on the corresponding image for Leon to imitate while saying, "Touch this for [activity name]."

he was prompted to mand for the corresponding item, in order to ensure consistency between choice and the items retrieved. When Leon emitted the targeted FCR (mand) with correct item correspondence, he was given access to the items for 30 seconds.

Phase 3 Tolerance Response Training. Following the mastery of Phase 2, delayed reinforcement was introduced which required Leon to demonstrate tolerance response (i.e., giving a thumbs-up in response to being told to wait and waiting for the entire programmed delay interval to elapse without engaging in any precursor or problem behaviour) to gain access to the preferred items. At the beginning of the phase, the terminal delay for this phase was identified and set to 11min based on an interview with Leon's parents. Sessions were conducted across multiple days, consisted of five randomised trials per session (i.e., two immediate and three contingency-based progressive delays) and the orders were pre-determined before the sessions. Environment arrangement was the same as in Phase 2 and the sessions always began with the delivery of a verbal S^D "If you want anything here, you can let me know." During immediate trials, the emission of FCRs resulted in immediate access to the items corresponding to the selected activity. For delayed trials, when Leon emitted the FCRs, we showed both palms to him, signaling him to wait and gave verbal S^D, "You need to wait for that, Leon. Is that okay?" while showing a thumb-up. Once Leon acknowledged the wait by responding with a thumb-up, the targeted wait interval began. If Leon engaged in precursor behaviour before wait interval elapsed, a redirection was provided verbally by saying, "No, you have to wait for it. Please sit down." Once Leon sat down and was not engaging in any precursor or problem behaviour, the timer was restarted (Ghaemmaghami et al., 2016). Once he did not engage in any precursor problem behaviour throughout the wait duration, he was given access to the item alongside with a verbal praise, "Thanks for waiting, Leon. You may go get the items." The duration of reinforcement was consistently set at 25% of the delay interval, with a minimum duration of 30s (e.g., 300s wait interval resulted in

approximately 75s of reinforcement duration) (Brown & Nercesian, 2024).

Initially, the wait interval was programmed at 5s. Following two consecutive trials with or without problem behaviour, the wait interval was decreased or increased, respectively. Overall, the delay intervals were increased gradually from 5s to 90s (5s for delays below 30s, 15s for delays from 30s to 60s, 30s for delays from 60s to 300s and 90s for delays from 300s to 660s). When the wait interval reached 570s, a variable schedule was introduced, so that each delay trial in a session had different wait intervals, but the average of these intervals matched the predetermined wait time (e.g. two different wait intervals of 540s and 600s which averaged to the predetermined wait time of 570s). From wait interval of 30s onwards, during sessions at home Leon was provided with a competing stimulus (i.e., a phone and headphones for listening to music) noncontingently and continuously (Austin & Tiger, 2015; Hagopian et al., 2005), along with a verbal S^D, "You may listen to music while you wait." Alternatively, Leon was also allowed to engage in other in-home activities (e.g., making a drink or food, using the toilet, walking to his room) while waiting for access to the item. For sessions at the centre, during the wait interval, Leon was allowed to either listen to music or engage in learning activities.

Phase 4 Denial Training. Once Leon had mastered and demonstrated tolerance at the terminal delay interval, we subsequently introduced a denial trial into the session, where each session consisted of five predetermined randomised trials (i.e., two immediate, two delayed and one denial trial). Similar to the previous phase, sessions always began with the delivery of a verbal S^D and the procedures for immediate and delayed trials were exactly the same, except that only the terminal delay interval (i.e., 11 minutes) was used during the delayed trials. For denial trials, when he emitted the FCR, we denied his access to the preferred item while saying, "Sorry, that's not available. Do you want to do another activity instead?" The denied item was then withdrawn for the rest of the trial and reuse in the next. When the

alternate item or activity was accepted, we provided verbal praise (e.g., “Thanks for accepting that”). However, if the alternate item or activity was not accepted, another item or activity was offered to him. Episodes of precursor or problem behaviour during the session resulted in either verbal redirection (e.g., requesting that Leon calm down and sit down) or response blocking (e.g., physically stopping Leon from taking the items). The goal of this phase was for Leon to demonstrate an appropriate denial tolerance response, when access to the preferred items was denied, for three consecutive sessions.

Results

Functional Assessment Interview

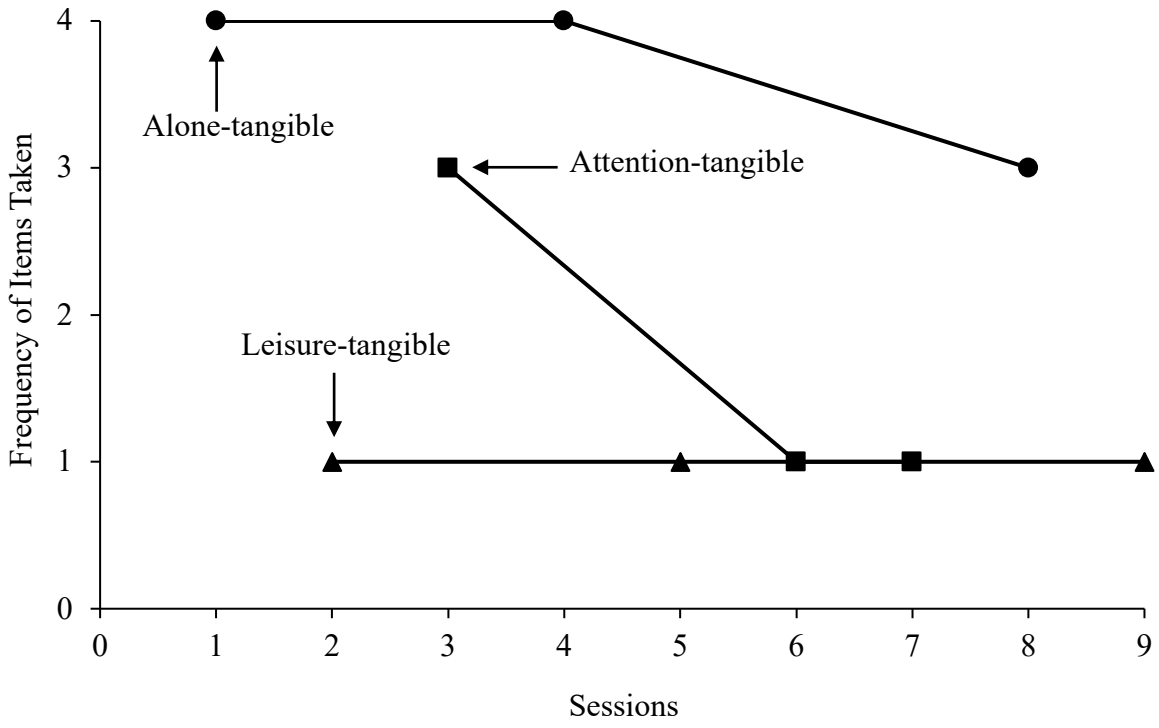
During the interview, the parents expressed their concern about Leon’s communication needs, given that he may need to live in a shared residential home in the near future. They also provided information about Leon’s learning history (i.e., picture book communication), preferred activities (i.e., making art items and engaging with sensory items) and competing stimuli (i.e., listening to music). Parents also described the conditions in which Leon’s problem behaviour (i.e., taking items that belong to others without permission and hiding them) reliably occurred when highly preferred items (i.e., art materials or sensory objects) were present in the environment.

Functional Analysis

Figure 1 shows the FA results for Leon. Across the sessions, Leon’s problem behaviour was consistently highest during the alone-tangible condition. Problem behaviour during this condition occurred at hiding four items per session in the first and fourth sessions, then decreased slightly to about three items in the eighth session. This pattern showed relatively stable and elevated rates of problem behaviour when Leon was isolated without access to social interaction but had continuous and unrestricted access to targeted materials. In contrast, problem behaviour in the attention-tangible condition began at a moderate level

Figure 1

Functional Analysis Results



then declined over subsequent exposures. The first session produced around three instances of problem behaviour, but by the sixth and seventh sessions the frequency had decreased to approximately one instance per session, which was comparable to the leisure-tangible condition. This downward trend suggested that social attention was not the maintaining factor for the target behaviour in a consistent way and it might have extinguished across repeated attention sessions.

Problem behaviour was the lowest and most stable in the leisure-tangible (control) condition. Across all leisure-tangible sessions, Leon engaged in the target behaviour at a constant rate of one instance per session, with no variability. Although there was some differentiation between the alone condition and the low and stable rates in the leisure condition, the results indicated that Leon's problem behaviour was most likely to occur when others were not present and less likely to occur when there was a preferred competing

contingency (i.e., listening to music, dancing).

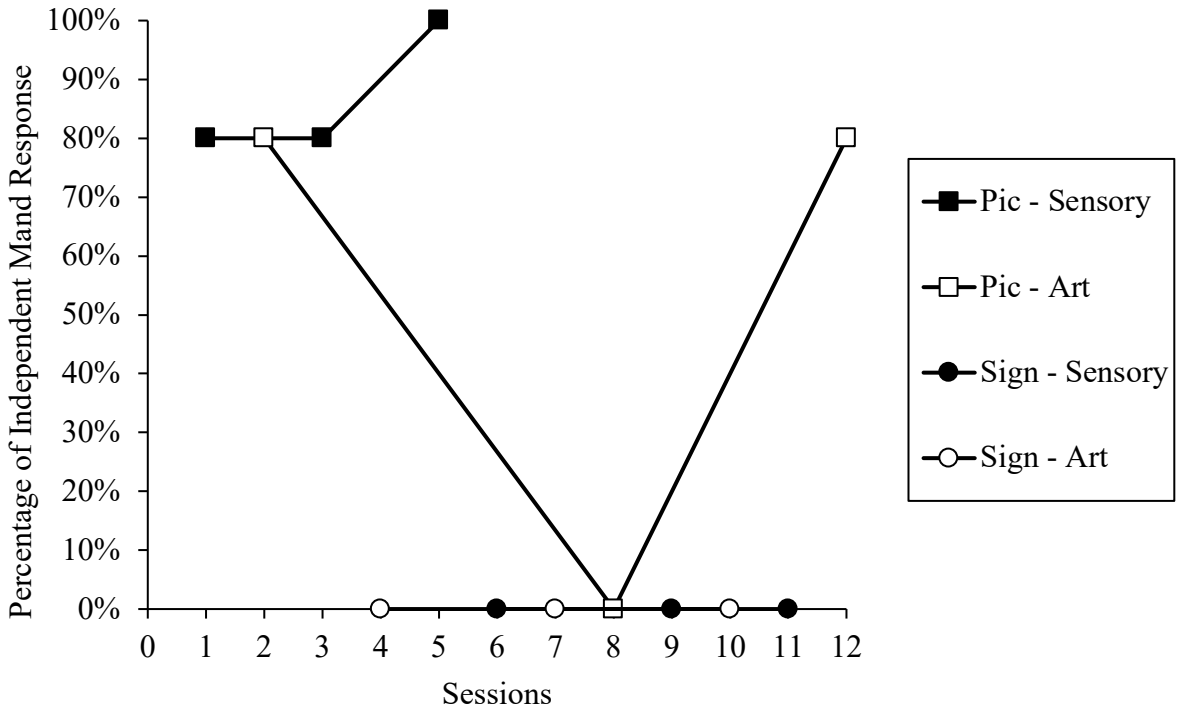
Mand Modality Assessment

Figure 2 shows the results from the MMA. Across the sessions sampled as shown in the figure, sign-base manding produced no independent response for either items. The data points for sign constantly remained unchanged at 0% throughout all sessions.

In contrast, picture communication showed a stronger trend. Manding using the picture-based mode for sensor items showed high, stable and independent responses early on at around 80% in the first two sessions and then improved to 100% during the third session. Manding for art materials using the picture-based mode had some variability of independent mands. Data were initially high at 80% in the first session, then dropped sharply to 0% in the second session, before recovering back to 80% by the final session. Despite this variability, the overall data for the picture-based mode had a higher percentage of independent responding compared to sign-based mands.

Figure 2

Mand Modality Assessment

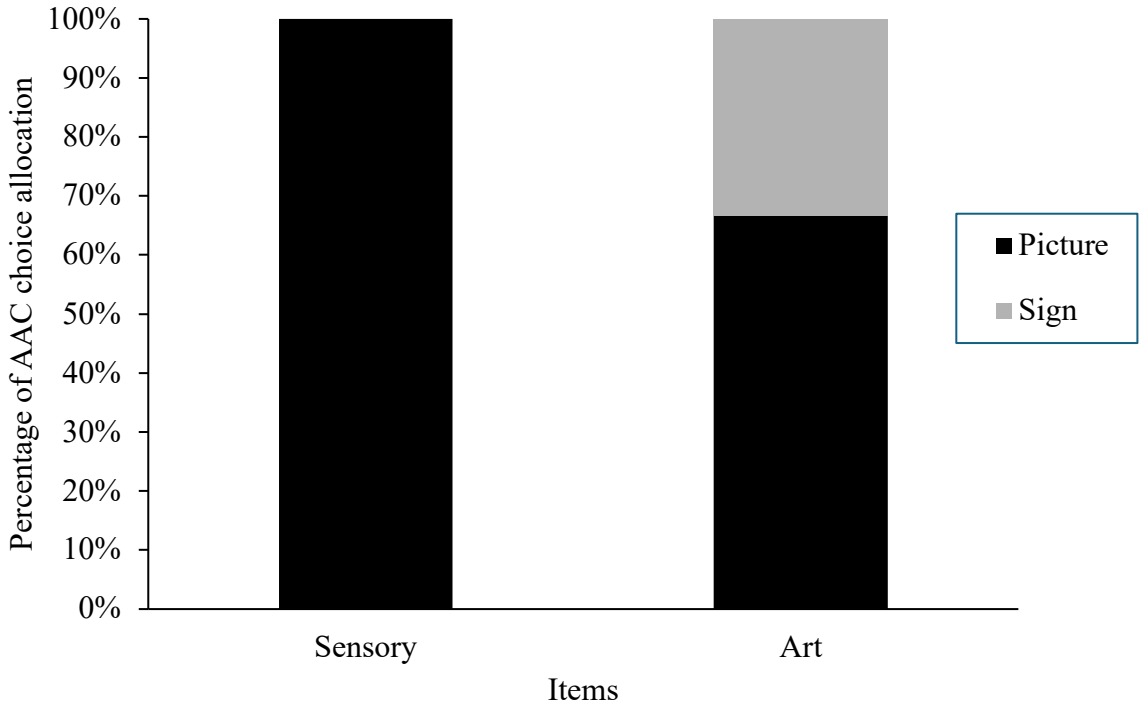


Modality Preference Assessment

Figure 3 shows Leon's preferred mand modality response over two different preferred activities. For sensory items, responding was exclusively via picture communication sheet, accounting for 100% of trials, with no MS responses observed. In contrast, art materials produced a more mixed pattern, where picture communication responses still dominated at roughly two thirds of the trials, while MS responses made up the remaining one third. This indicated that picture communication was the most preferred modality for Leon across both activities.

Figure 3

AAC Modality Preference

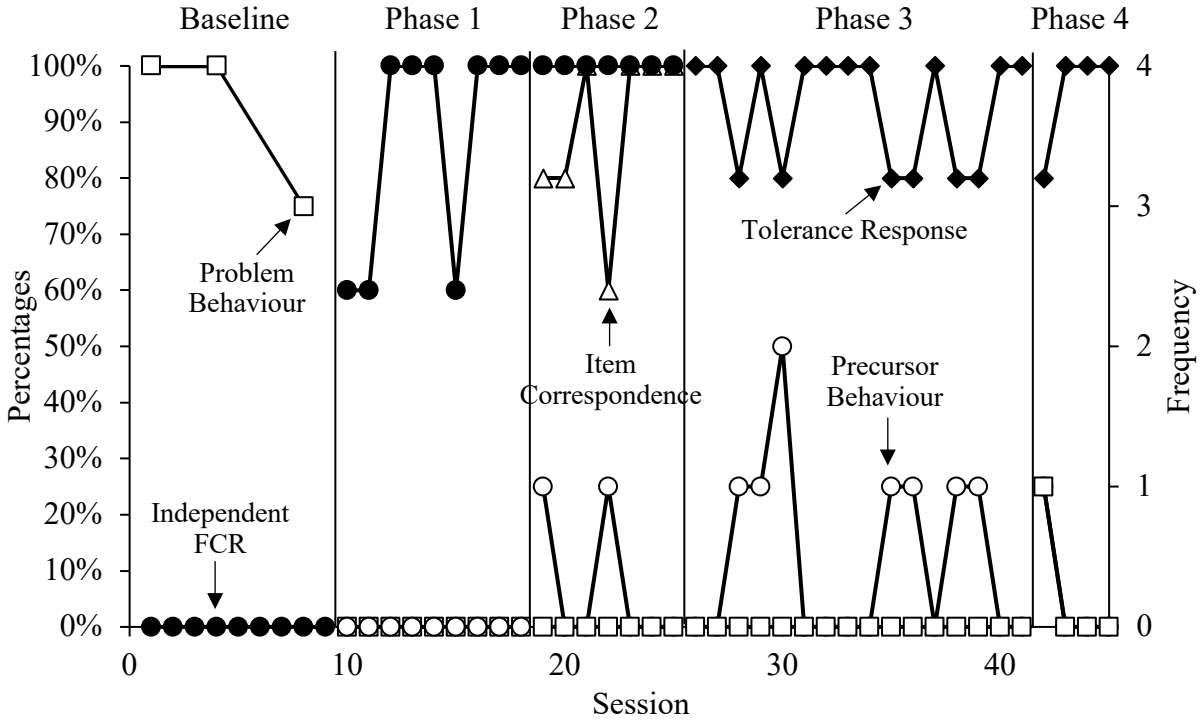


Functional Communication Training

Figure 4 illustrates Leon's FCT intervention progress across phases. Problem behaviour constantly remained at zero throughout the intervention phases, with only a single instance during session 42, suggesting that the intervention maintained the behavioural

Figure 4

Intervention Phases for Leon



Note. Independent FCR, item correspondence and tolerance response were measured in percentages (left y-axis). Precursor and problem behaviour was recorded as frequency (right y-axis) across sessions.

stability even when delayed and denial of reinforcement were introduced while new skills were strengthened.

Baseline. Independent emission of FCR remained constantly at 0% across all sessions. In contrast, problem behaviour occurred at high and relatively stable levels, ranging from 3 to 4 responses in over three sessions.

Phase 1. Leon's independent use of the picture-based modality for manding was 60% (three out of five trials) across the first two sessions, during which prompts were provided when Leon attempted to reach for the items without emission of the targeted FCR. Subsequently, it increased to 100% for three sessions, followed by a brief decrease to 60% at

session 15. The FCR responding was then further strengthened until a stability criterion of three consecutive sessions at 100% was met, at which point steady emission of targeted FCR was considered achieved. Although there were some brief variabilities, these data indicated Leon's rapid acquisition of the FCR, followed by stable and high levels of independent responding by the end of the phase.

Phase 2. Leon's independent FCR emission remained at 100% across all sessions and that prompting was not required. Initial accuracy of item correspondence (i.e., the item retrieved corresponded with the FCR) was 80% for the first session. In subsequent sessions, Leon showed a brief variability in item correspondence, with 60% correspondence accuracy during session 22, before showing an increase to 100% correspondence accuracy through the remaining sessions of the phase. However, there were occurrences of Leon's precursor behaviour in which he attempted to retrieve the items without permission but were quickly redirected by the researcher to use the modality for mand response. These data indicated that Leon maintained the emission of FCR independently while acquiring item correspondence accuracy across relatively few training sessions.

Phase 3. High tolerance response in the early phase indicated that Leon was able to tolerate the short wait intervals without engaging in problem behaviour, although there were some precursors occurred occasionally. During Session 30, when delay intervals began to increase substantially longer, Leon engaged in precursor behaviour in two out of five trials by attempting to gain access to the items without permission, although he was provided with a competing stimulus noncontingently. Following the precursor, he was verbally redirected back to his seat. Then, he tolerated the wait interval for the rest of the trial without escalating into problem behaviour. For the remaining sessions, despite there were some intermittent occurrences of precursor behaviours, Leon demonstrated a relatively stable delay tolerance response while engaging with the competing stimulus until terminal delay was achieved. No

problem behaviour was observed throughout the entire phase.

Phase 4. Tolerance response (i.e., delayed and denial tolerance) increased rapidly at the start of the phase, with initial performance at 80% during the first session. This reflected a denial trial at session 42 in which denial was first introduced to the FCT, Leon's access to the requested item was denied and he did not accept the offered alternative (i.e., listening to music). Subsequently, he engaged in both precursor and problem behaviour (i.e., reaching towards items and taking an item without permission). For the remaining three sessions, tolerance responding occurred at 100%, after which we concluded that Leon had met the mastery criterion for Phase 4 and demonstrated consistent denial tolerance (i.e., accepting unavailability when presented with an alternative) without any resurgence of precursor or problem behaviour.

Discussion

The present study aimed to replicate and extend the literature by integrates procedures from multiple studies (Brown & Nercesian, 2024; Hagopian et al., 2005; Kunnavatana et al., 2018; Snyder et al., 2024) with an adult participant. The finding of this study adds to a growing body of applied work showing that the combination of behaviour-analytic assessment, function-based treatment and AAC modalities can be extended to autistic adults with DDs, a group that remains comparatively underrepresented in the intervention literature despite high rates of problem behaviour and substantial service needs (Álvarez-Couto, 2024; Bowring et al., 2017; Poppes et al., 2010). Similar to the finding reported by Sheen et al. (2024), the modified brief FA implemented in the study demonstrated its effectiveness in identifying multiple maintaining variables for Leon's problem behaviour, which is crucial for designing subsequent interventions. Additionally, this study is also aligns with findings from Carnett et al. (2025) by highlighting that modality selection should prioritise the learner's learning history and preference when FCT interventions include AAC-based FCRs, as these

factors can directly affect the learner's acquisition rate and promote self-determination. The inclusion of MMA within a complex FCT in this study is noteworthy since most delay and denial literature has only prioritised tolerance training and schedule thinning without systematically evaluate the individual preferred modality through which the FCR is taught and maintained (Austin & Tiger, 2015; Brown & Nercesian, 2024; Edelstein et al., 2021; Snyder et al., 2024). The study outcomes converged on three main findings:

1. The result of FA indicated that Leon's problem behaviour was most likely to occur more frequently in the absence of social contact.
2. Picture communication produced substantially stronger and faster acquisition and preference outcomes than signing during the MMA and choice probes.
3. When the preferred picture modality was embedded into FCT, Leon maintained high levels of independent emission of the FCR and progressed through DDTT with very little problem behaviour and precursor behaviour, such that minimal response redirection was required across the intervention sessions.

As Leon's problem behaviour involves taking others' property (e.g., stealing and/or hiding items), this often results in restrictive practices such as reduced freedom, increased supervision and avoidance of environments that may evoke the problem behaviour, which in turn exacerbates the barriers to his participation in the community (Bowring et al., 2017; Smith et al., 2020). In this context, it was important to incorporate FCT as a core treatment component because of Leon's limited functional communication skills and since his problem behaviour occurred contexts with and without supervision. Therefore, teaching Leon a functionally equivalent FCR could provide a proactive and least-restrictive alternative that could be used across social contexts, thereby reducing the need for intensive supervision.

Although FCT and DDTT were effective at replacing problem behaviour associated to stealing for Leon, it may also be important to evaluate additional conditions that could help to

ensure the lasting effects of this intervention, such as other competing contingencies (e.g., reduced supervision) rather than relying solely on FCT and schedule thinning. This is because, conceptually, it is challenging to implement such complex training with adults, especially in naturalistic settings, because they have longer reinforcement history and broader access to obtaining reinforcers. Therefore, another approach is to assess whether enriching Leon's environment with high-quality, preferred social reinforcement and leisure engagement might compete with the maintaining contingencies for his problem behaviour. This inference is based on the results obtained in FA, where Leon's problem behaviour occur less frequently when he was in environment with rich social interactions (i.e., leisure-tangible condition). Research findings by Hagopian et al. (2005) and Austin and Tiger (2015) further support that programming competing stimuli and alternative reinforcers can increase tolerance to decrements in the reinforcer density and reduce the likelihood of escalation in problem behaviour when reinforcement is delayed. Hence, this empirically supported approach may offer Leon a socially valid pathway to reducing his problem behaviour while supporting the sustained engagement across settings.

A further contribution of this study is the strength and flexibility of FA as a method for identifying the maintaining variables of complex problem behaviour. Unlike the usual procedure described by Northup et al. (1991), this study used a modified brief FA (Sheen et al., 2024) with combined test conditions to match Leon's unique topography. The FA therefore provided a feasible and efficient assessment format while still producing clinically meaningful information about Leon's problem behaviour. Although the FA results indicated that his behaviour is more likely to occur at a higher frequency during certain conditions (i.e., tangible access and the absence of social contact), it was also important to consider Leon's lack of communication skills, to informed the design of intervention (Carr & Durand, 1985; Tiger et al., 2008). This is similar to Sheen et al. (2024), where FA was used to clarify the

functional purpose on hoarding behaviour, demonstrating that FA can be adapted to atypical topographies while retaining its experimental logic. Importantly, the finding of FA literature and present study demonstrates that such flexibility can be extended to different contexts and that makes it more practical to use in real-world settings while still keeping the main purpose of identifying the maintaining variables for problem behaviours (Bloom et al., 2011; Northup et al., 1991).

AAC assessment outcomes represent another important contribution of the study, particularly because AAC decision-making is often treated separately rather than being a part of a whole function-based behavioural support plan. Although many studies have evaluated FCT with DDTT, for example Brown and Nercesian (2024), Edelstein et al. (2021), Snyder et al. (2024), Austin and Tiger (2015) and Ghaemmaghami et al. (2016), none of these has incorporated assessments to identify the suitability of various AAC modalities for the individual and evaluate their preferences within the research context. This study, thus, has extended the literature by integrating a structured evaluation of AAC modality assessment and preferred mand modality as a part of FCT for adults who have had prior AAC exposure. The overall responding across the intervention shows that selecting a suitable and preferred communication modality can effectively reduce problem behaviours. This multi-phase assessment of the study is consistent with the emerging behaviour-analytic approaches that treat mand topography selection as an empirically testable decision, not merely a clinical judgement (Carnett et al., 2025; Kunnavatana et al., 2018; Torelli et al., 2016).

Evidence from AAC research suggests that learners with ASD can acquire communication via multiple modes, but acquisition and maintenance often depend on response effort, discriminability and prior reinforcement history (Frolli et al., 2022; Tincani, 2004; van der Meer et al., 2012). Consistently, the present study highlights how AAC systems can serve as efficient and socially acceptable response forms that can compete with problem

behaviour when reinforcement contingencies are arranged appropriately (Tiger et al., 2008; Walker et al., 2018). For Leon, although he had prior exposure to sign and picture-book communication, he had not been exposed to the novel signs used in this study or the picture symbols on the picture-based system. The laminated picture communication board was designed to mirror his old system, which may have reduced response effort and supported efficiency of use and acquisition rates. In contrast, manual sign required fine motor shaping and movement sequences that may have been higher effort, less discriminable and less likely to be emitted independently without a longer reinforcement history. The results demonstrated that response efficiency has strong effects on behaviours in persisting through everyday routines and learning (Carnett et al., 2019; Horner & Day, 1991). If an FCR is more effortful and less reliable than the problem behaviour, it is less likely to be emitted even when MOs are high.

Further, selecting a mand topography based on the individual's preference may also affect rate of acquisition and the durability of FCT in cases where reinforcement becomes leaner or less predictable, and provide opportunities for self-determination. When the communication response is preferred, it can compete with problem behaviour more effectively. Studies that directly assess mand topography preference indicate that learners can display clear and idiosyncratic preferences among AAC-based FCR and that embedding preferred topographies can improve engagement and reduce the likelihood of treatment breakdown when conditions become more challenging (Kunnavatana et al., 2018; Torelli et al., 2016). Consistent with the findings of Kunnavatana et al. (2018), Leon's independent use of the AAC modality increased quickly to high levels during Phase 1 and remained high across later phases, indicating a strong acquisition trajectory and maintenance use of the skill once established (Carnett et al., 2025; Tiger et al., 2008). This is important because FCT commonly becomes vulnerable to resurgence of problem behaviour during schedule thinning,

delay and denial conditions that reduce the reinforcer density for FCR. If the alternative response no longer produces the best payoff, resurgence of problem behaviour may occur easily (Durand & Carr, 1992; Tiger et al., 2008). Therefore, preference assessments for mand topographies show that individuals will differentially allocate responding to the modality they prefer and that preferred forms may show greater persistence of use over time, thus help to prevent resurgence of problem behaviour (Kunnavatana et al., 2018; Ringdahl et al., 2018; Torelli et al., 2016).

The most clinically meaningful element of the current study may be its explicit focus on maintenance conditions that includes thinning of reinforcement schedules and teaching tolerance to delayed and denial of reinforcement. As maintenance has been identified as a persistent challenge in FCT, particularly when natural environments cannot sustain immediate and dense schedules of reinforcement for every FCR (Durand & Carr, 1992; Neely et al., 2018), the study's multi-phase structure reflects the progression in our field when providing FCT interventions that are to designed for durability rather than short-term suppression of problem behaviour. Besides, teaching correspondence also served as a direct competing response class where Leon learned a discriminated chain in which he requested, approached the box and selected only relevant corresponding items. Such quick resolution of correspondence errors shows that pairing brief and low-intensity correction with reinforcement for correct correspondence was sufficient to establish a discriminated responding that may be particularly important for adults who have long learning histories.

Tolerance training is well supported in the literature as a method to reduce resurgence of problem behaviour when reinforcement density decreases after acquisition of FCR. Pioneering work showed that systematically increasing delay intervals can facilitate tolerance while maintaining low rates of problem behaviour, especially when procedures are carefully programmed (Fisher et al., 2000). Subsequent research by Austin and Tiger (2015) and

Hagopian et al. (2005) emphasised that introducing alternative reinforcers or competing stimuli can further support schedule thinning by reducing the value of immediate access to the functional reinforcer during delay intervals. The competing stimulation for Leon during longer delay intervals is found to be consistent with this line of work and offers an applied example of how to maintain behavioural stability when immediate access is not available. In addition, the verbal and visual cues (e.g., “You need to wait” paired with the thumbs-up signal and the timer) provided may have helped Leon to discriminate between delayed trials and immediate reinforcement and subsequently allocate responding towards the waiting response rather than attempts to access items without permission. This is consistent with Brown and Nercesian (2024), who highlights the role of S^D in promoting delay tolerance by clarifying contingency changes and reducing uncertainty about when reinforcement will be available. Denial tolerance training further extends this logic by addressing situations where reinforcement is unavailable. The result obtained aligns with the concept that contingencies can promote tolerance to delays and disruptions by shaping persistence in appropriate behaviour and decreasing the reinforcement value of problem behaviour (Edelstein et al., 2021; Ghaemmaghami et al., 2016; Snyder et al., 2024). Leon’s successful progression through denial training without resurgence of problem behaviour suggests that the combination of clear signals, consistent contingencies and alternative stimuli can help prevent the resurgence where FCR and problem behaviour compete under lean or unpredictable reinforcement conditions (Durand & Carr, 1992; Wacker et al., 2011). Thus, the present outcomes support the position that tolerance training should be treated as a core component of FCT planning, especially in adult services where immediate reinforcement is often unrealistic.

The study has implications for Leon as it suggests a practical pathway to reduce the need for restrictive access and avoidance of certain environments by replacing his problem

behaviour with an efficient and socially valid way to request access items. In addition, improving functional communication and reducing problem behaviour can also have benefits for adult disability services, staff wellbeing and ethical support provision. Problem behaviour in adults with DDs often lead to increased demands on DSPs, such as staff stress and burnout, particularly when staff are frequently exposed to aggression and emotionally demanding (Chung & Corbett, 1998; Hensel et al., 2011). This is especially relevant because systemic barriers to healthcare and disability supports can delay or limit their access to appropriate services, which exacerbate the unmet needs. From an ethical standpoint, interventions that build autonomy-supportive communication and tolerance skills may better align with least restrictive practice because they increase the individual's repertoire for navigating through daily routines without constraint (American Speech-Language-Hearing Association, n.d.; Wacker et al., 2005). Furthermore, the emphasis on low-tech AAC modalities and structured contingency programming also enhances the practicality in settings with limited access to high-tech resources or staffing issue.

Despite the strengths, several limitations restrict the interpretation of these findings. First, this was a single-case research with only one participant, which greatly limits the generalisability of the findings, such that Leon's history with picture communication may have made picture-based FCR particularly likely to succeed. Second, although the intervention was implemented across two different settings (i.e., home and community centre), the extent of generalisation to other contexts, such as when Leon is alone or out at a shop in the community remains unknown. Third, due to time constraints, there were some procedural limitations. We did not include assessment of competing stimulus during early phase, as demonstrated in Kunnavatana et al. (2018), because the information was provided by the parents during FAI. Although the outcome from the current study shows that the competing activity identified by the parents (i.e., listening to music) were sufficient to

support Leon throughout the DDTT, the lack of formal assessment may be a limitation. We also did not evaluate generalisation effects, such as conditions where there was limited supervision in the environment that required persistence of the FCR (e.g., going to find a communication partner to engage in the FCR or waiting until the communication partner was present in the environment), or across other communication partners (e.g., parents, support staff). This matters because limited generalisation across contexts and people may reduce the likelihood that Leon will consistently use the FCR outside of the training conditions, thereby increasing the risk of relapse or resurgence of problem behaviour. Fourth, defined rule for schedule progression used during Phase 3 was lean compared to previous research and may be insufficient to demonstrate a reliable behavioural change. However, this decision was made partly due to the lack of problem behaviour seen in the prior phases, suggesting that the teaching procedures and S^D were already supporting tolerance, and the need to progress efficiently towards the denial phase. Fifth, only some social validity data (e.g., FAI and MMA assessment) was collected during the study and was not evaluated at the outset. Thus it is unclear if the outcomes were viewed as desirable by Leon and his communication partners. Despite these limitations, the findings of the current study are a promising step towards providing innovate function-based treatment that include careful assessment of AAC modalities for adults with DDs and CCNs.

In light of these limitations, future research is needed to replicate multi-phase AAC-informed extended FCT treatment with other adults, including those with other functions of problem behaviour and different histories with AAC systems (e.g., sign, picture systems, or tech-based systems). Comparative work suggests that while manual signs can be effective for some individuals, picture-based systems and SGDs may be more accessible for others depending on their motor skills, preference, reinforcement history and their communication partners. Another focus is to strengthen the generalisation by testing the intervention

outcomes with support staff, across different environment and in environments with higher density of competing stimuli and novel potential "target" items, as well as conditions (e.g., being alone versus supervised). Future research should also include elements of generalisation, such as parent and staff training to ensure the maintenance of FCR. Reviews of FCT literature emphasise that maintenance and generalisation require explicit programming and monitoring because treatment effects can be weakened when contextual supports change (Neely et al., 2018; Wacker et al., 2011).

Conclusion

In conclusion, the present study illustrates the value of functional assessments for identifying the likely maintaining variables of problem behaviour, including behaviours that may be automatically reinforced or linked to complex routines, which is essential for effective intervention planning. In addition, it demonstrates that matching AAC system to the individual's abilities, repertoire and preference is an essential component of intervention design that can improve the efficiency of the learning process and durability of FCT significantly, alongside AAC guidance and behavioural assessment methods. Lastly, it provides empirical support for embedding DDTT within FCT as a proactive strategy for maintenance under realistic contingencies, aligning with the strong evidence base for schedule thinning, competing stimuli and tolerance training. Due to time limitations, further support (e.g., skill maintenance and generalisation, parent training) will be provided to the family outside the scope of this thesis.

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Appendix A

Consent Form for Caregiver and Support Staff

UNIVERSITY OF WAIKATO
DIVISION of ARTS, LAW, PSYCHOLOGY & SOCIAL SCIENCES

CAREGIVER/SUPPORT WORKER CONSENT FORM
[A completed copy of this form should be retained by both the researcher and the participant]

Study title: The long-term effects of functional communication training for adults with developmental disabilities

Lead investigator: Dr. Amarie Carnett, Ph.D.

Contact phone number: 022 627 4305

**Please note, an interpreter is available upon request.*

Directions: Please tick each item to indicate your consent.

I have read, or have had read to me, and I understand the Participant Information Sheet.	
I have been given sufficient time to consider whether or not to participate in this study.	
I have had the opportunity to use a legal representative, whanau/family support or a friend to help me ask questions and understand the study.	
I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet.	
I understand that taking take part in this study is voluntary (my choice) and that I may withdraw from the study at any time.	
If I decide to withdraw consent from the study, I agree that the information collected up to the point when I withdraw consent may continue to be processed.	
I understand that my participation in this study is confidential and that no material, which could identify them, will be used in any reports on this study.	
I know who to contact if I have any questions about the study in general.	
I understand what is involved in my participation in the study.	
I wish to receive a summary of the results from the study.	Yes ☐ No ☐

UNIVERSITY OF WAIKATO
DIVISION of ARTS, LAW, PSYCHOLOGY & SOCIAL SCIENCES

Declaration by participant:
I hereby consent to participate in this study.

Participant's name: _____

Signature: _____ Date: _____

Declaration by member of research team:

I have given a verbal explanation of the research project to the participant, and have answered the participant's questions about it.

I believe that the participant understands the study and has given informed consent to participate.

Researcher's name: _____

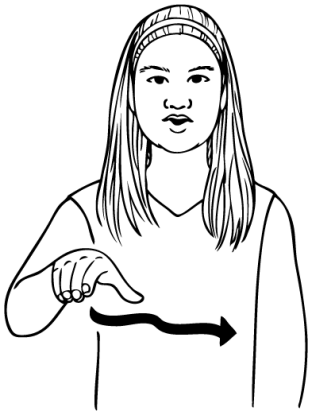
Signature: _____ Date: _____

Appendix B

New Zealand Sign Language Vocab Sheet

NZSL ONLINE

Your vocab sheet



toy

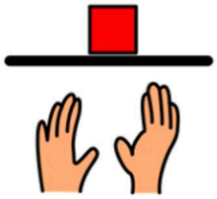
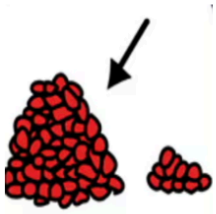
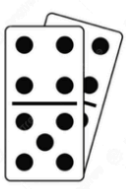
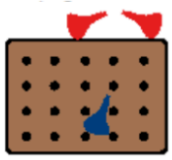
takawairore, taonga tākaro

art

toi

Appendix C

Low-tech Aided AAC Picture System for Leon

I 	Want 	Who? 	What? 
Stop 	More 	My Turn 	Finish 
Torch 	Puzzle 	Dance 	Sensory Items 
Art Supplies 	Dominos 	Numicon 	Sand 

Appendix D

Brief Functional Analysis Data Sheet and Treatment Integrity Collection Form

Date		Client	
Time		Caregiver	
Researcher			

Brief Functional Analysis Data Sheet

Problem Behaviour: Hoarding/hiding is defined as taking an item that is not required for the current activity and move an item to a non-visible (e.g., inside his backpack, shopping bag, jacket or cover with a paper) or semi-visible (e.g., sitting on it, tuck into his laps) locations, so it cannot be seen without opening or moving something or can be partially seen.

Direction: Observe and record the number of items hoarded/hid in each session in the ***No. of Items*** columns. Record the interval, in second, between antecedent and the onset of the target behaviour in the ***Latency*** columns. Record in the ***Independent FCR*** column if there is any mand response. Each session is 5-minutes and 3 sessions of each condition are conducted.

	Condition								
Session	**Control-Tangible (Play)**			**Alone-Tangible**			**Attention-Tangible**		
	No. of Items	**Latency (second)**	**Independent FCR**	**No. of Items**	**Latency (second)**	**Independent FCR**	**No. of Items**	**Latency (second)**	**Independent FCR**
1									
2									
3									
4									
5									
6									
7									
8									
9									

Notes:

Date		Client	
Time		Caregiver	
Researcher			

Brief Functional Analysis Treatment Integrity

How to Score: If the researcher completes the criteria listed, mark a "✓" in the column corresponding to the trial number. If they did not complete that criteria during the session, mark a "**X**".
How to Implement: Remove any unnecessary stimuli from the room and set up with toys or objects that the client may be interested in. Make sure that all necessary materials, such as the data sheets, video recording phone, etc., are ready before continuing with the FA. Each session is 5-minutes and 3 sessions of each condition will be conducted. Sessions are conducted across multiple days.

Termination Criteria: If client leaves the room or someone enters the room during the session
Problem Behaviour: Hoarding/hiding item
Materials:

- Data Sheets
- Targeted leisure items (e.g., shiny objects, sensory toys, pens, papers, sellotapes, brochures)
- Hiding items/location (e.g. backpack, shopping bag, jacket, paper to wrap item, clothing pockets)
- iPhone for video recording

PLAY/CONTROL CONDITION			
A video recording iPhone is set up in the room to record the session.			
Client and researcher are listens to music using earphone.			
Client has free access to targeted leisure items and objects/locations to hide objects			
Researcher delivers attention (e.g., thumbs up or comment) to client approximately every 30s			
Researcher ignores target and all other inappropriate behaviours and problem behaviour produces no consequence.			
Total correct:			
Percentage correct:			

ATTENTION CONDITION			
Client has access to targeted items and objects/locations to hide the objects.			
A video recording iPhone is set up in the room to record the session.			
At the start of the session, researcher removes their attention from the client.			
Researcher ignores all non-targeted behaviours from the client.			
Contingent upon target behaviour, researcher immediately provides brief attention to client and says "Yes, you can have that".			
Total correct:			
Percentage correct:			

ALONE CONDITION			
All unnecessary stimuli are removed from the room and room is prepped with targeted items.			
A video recording iPhone is set up in the room to record the session			
At the start of the session, client is left alone in the room and the research says, "I'll be right back, you can stay here"			
Client has free access to the preferred leisure items and hiding items/location			
Problem behaviour produces no consequence.			
Total correct:			
Percentage correct:			

Appendix E

Mand Modality Assessment Data Collection and Procedural Integrity Form

Multi-mode FCT

Researcher: **Participant:**
Date: **Primary/IOA:**

Directions: Randomize each block of trials for modality w/counterbalancing (6 total blocks). Following each trial block, provide a choice probe (via brief multiple stimulus assessment).

Session #:						
AAC Mode:					Resistence to prompt?	Comments
Item used:						
Trials	Response/Prompt Level					
1	PP	V/M	G	IN	Y / N	
2	PP	V/M	G	IN	Y / N	
3	PP	V/M	G	IN	Y / N	
4	PP	V/M	G	IN	Y / N	
5	PP	V/M	G	IN	Y / N	

Session #:						
AAC Mode:					Resistence to prompt?	Comments
Item used:						
Trials	Response/Prompt Level					
1	PP	V/M	G	IN	Y / N	
2	PP	V/M	G	IN	Y / N	
3	PP	V/M	G	IN	Y / N	
4	PP	V/M	G	IN	Y / N	
5	PP	V/M	G	IN	Y / N	

Session #:						
AAC Mode:					Resistence to prompt?	Comments
Item used:						
Trials	Response/Prompt Level					
1	PP	V/M	G	IN	Y / N	
2	PP	V/M	G	IN	Y / N	
3	PP	V/M	G	IN	Y / N	
4	PP	V/M	G	IN	Y / N	
5	PP	V/M	G	IN	Y / N	

Fidelity	Session #	Session #	Session #
	+/-	+/-	+/-
Brief Preference assessment will be conducted to determine what activity the participant would like to engage with (e.g., sensory toy or art).			
Participant will be seated at the table facing the researcher.			
Items from the FA, are visually present but not within reach. When the participant indicates that they are interested in the item (e.g., reaching, pulling adult to them, shifting eye gaze, etc.), the researcher will prompt the the participant using graduated prompting procedure to use the AAC mode (i.e., sign, PE, or SGD) if a independent request is not emitted.			
After the participant correctly responds using the AAC mode, the researcher will provide brief access to the item and descriptive social praise (e.g., "Here's the art supplies").			
For each session 5 trials will be conducted with the randomly assigned modality.			
TOTAL			

Appendix F

Mand Modality Preference Assessment Data Collection and Procedural Integrity Form

Modality Preference Assessment

Researcher : _____ Participant : _____

Circle one : Primary / IOA

Date	Trial #	Item Used	AAC Mode Used	Comment
	1	Sensory Art	Sign Picture	
	2	Sensory Art	Sign Picture	
	3	Sensory Art	Sign Picture	
	4	Sensory Art	Sign Picture	
	5	Sensory Art	Sign Picture	

Fidelity Checklist	Trial (✓ / X)				
	1	2	3	4	5
Participant is seated at the table facing the researcher.					
Brief preference assessment is conducted to determine what activity the participant would like to engage with (e.g., sensory break or art), such as asking "What do you feel like doing today?".					
Materials for both modalities will be previewed to Leo by holding up the corresponding material (e.g., picture communication sheet; visual image of the signs) and verbal S^D, saying "You can tell me with either x or x". Then the researcher will place the picture-based communication modality on the table within reach. The researcher will hold the visual sign sheet in Leo's line of sight.					
Once participant made a request using either of the modality, he is given brief access to the item and a descriptive social praise (e.g., "Here's your art supplies").					
Between trials, participant is given a brief break (e.g. two minutes) and he is allowed to engage in other daily activities (e.g. listening to music, making a cup of tea).					
Total					

Appendix G

FCT Phase 1 Data Collection and Procedural Integrity Form

FCT Datasheet

Date : _____ Phase : Phase 1

Researcher : _____ Participant : _____

Circle one : Primary / IOA

Direction : For ***prompting level*** column, model/vocal **(M/V)**, gesture **(G)**
For the ***response*** column circle + for independent and – for prompted.
For precursor behaviour column, mark ✓ if participant attempts to approach items without permission.
If not, circle **X**.

Trials #	Activity Chose	Prompting Level	Response	Prompting	Precursor Behaviour	Problem Behaviour	Comment
1	Sensory Art	M/V G	+ -	✓ ×	✓ ×	✓ ×	
2	Sensory Art	M/V G	+ -	✓ ×	✓ ×	✓ ×	
3	Sensory Art	M/V G	+ -	✓ ×	✓ ×	✓ ×	
4	Sensory Art	M/V G	+ -	✓ ×	✓ ×	✓ ×	
5	Sensory Art	M/V G	+ -	✓ ×	✓ ×	✓ ×	

Fidelity Checklist	Trial (✓ / X)				
	1	2	3	4	5
Participant is seated at the table facing the researcher.					
Brief preference assessment is conducted to determine what activity the participant would like to engage with (e.g., sensory activity or art activity), such as asking "What do you feel like doing today?".					
The picture-based communication sheet is placed on the table within participant's reach.					
Researcher provided a vocal prompt to the participant (e.g., "Here's your picture book in case you need to ask for something") while pointing at the picture book.					
Participant is allowed up to 3 seconds to make responses, after which prompting hierarchy is used accordingly for guidance and corrections of FCR.					
Once participant made a request using the FCR, they are given access to the item for 30 seconds and a descriptive social praise (e.g., "Here you go").					
All problem behaviours are ignored.					
Total					

Appendix H

FCT Phase 2 Data Collection and Procedural Integrity Form

FCT Datasheet

Date : _____ Phase : Phase 2

Researcher : _____ Participant : _____

Circle one : Primary / IOA

Direction : For ***prompting level*** column, model/vocal **(M/V)**, gesture **(G)** and independent **(Ind).**
For the ***response*** column circle + for independent and – for prompted.
For ***precursor behaviour*** column, mark ✓ if participant attempts to approach items without permission. If not, circle X.

Trial #	Activity	Prompting Level	Response Redirection	Precursor Behaviour	Item Correspondence	Error Correction	Problem Behaviour	Comment
1	Sensory Art	M/V G Ind	✓ ×	✓ ×	✓ ×	✓ ×	✓ ×	
2	Sensory Art	M/V G Ind	✓ ×	✓ ×	✓ ×	✓ ×	✓ ×	
3	Sensory Art	M/V G Ind	✓ ×	✓ ×	✓ ×	✓ ×	✓ ×	
4	Sensory Art	M/V G Ind	✓ ×	✓ ×	✓ ×	✓ ×	✓ ×	
5	Sensory Art	M/V G Ind	✓ ×	✓ ×	✓ ×	✓ ×	✓ ×	

Fidelity Checklist	Trial (✓ if completed or n/a X if not completed)				
	1	2	3	4	5
The preferred items are placed in bins across the room.					
Participant is seated at the table facing the researcher.					
The picture-based communication book is placed on the table within participant's reach.					
Once participant made a request using the FCR, researcher said, "Yes, you may go and get the items" and participant was given access to the item for 30 seconds.					
If the participant walks to a bin to get an item without emitting the FCR, the researcher provided a response redirection (e.g., stops the participant and handed them the picture book) while saying, "These are not yours, you need to ask."					
Participant is allowed up to 3 seconds to make responses, after which a least-to-most prompting hierarchy is used.					
If the participant does not show correspondence between the FCR item and the item retrieved, the researcher will provide an error correction (e.g., "That's not the item you asked for" and provide a gesture prompt towards the picture symbol that corresponds with the item that was retrieved.					
Total					

Appendix I

FCT Phase 3 Data Collection and Procedural Integrity Form

FCT Datasheet

Date : _____ Stage : Phase 3

Researcher : _____ Participant : _____

Circle one : Primary / IOA Session : _____

Direction : Condition for the trial will be pre-determined prior to the sessions. **Imm** for immediate trials, **Delay** for delayed trials.
For ***targeted delay interval*** column, **record** the delay interval (in seconds) used during the trial.
For ***precursor behaviour*** column, mark ✓ if participant engages in precursor behaviour. If not, circle X.

Trials #	Condition	Targeted Delay Interval (s)	Activity Requested	Precursor Behaviour	Verbal Redirection	Response Blocking	Problem Behaviour	Comment
1	Imm Delay		Sensory Art	✓ X	✓ X	✓ X	✓ X	
2	Imm Delay		Sensory Art	✓ X	✓ X	✓ X	✓ X	
3	Imm Delay		Sensory Art	✓ X	✓ X	✓ X	✓ X	
4	Imm Delay		Sensory Art	✓ X	✓ X	✓ X	✓ X	
5	Imm Delay		Sensory Art	✓ X	✓ X	✓ X	✓ X	

Fidelity Checklist	Trial (✓ if completed or N/A, X if not completed)				
	1	2	3	4	5
The preferred items are placed in bins across the room.					
Participant is seated at the table facing the researcher.					
The picture-based communication book is placed on the table within participant's reach.					
Once participant made a request using the FCR, researcher showed both palms to the participant, signaling to wait, and said, "You need to wait for that."					
The researcher started the timer after the participant acknowledged the wait with a thumbs-up.					
When the participant walked to a bin to get an item before wait interval was up, the researcher provided a response blocking (e.g., stopped the participant) while saying, "No, you have to wait for it. Please sit down" and restarted the timer.					
When the wait interval was up, participant was given access to the items for X-second (based on the calculated reinforcement duration) and researcher gave a verbal praise "Thanks for waiting. You can go get the items you want."					
The wait interval was increased after two consecutive no problem behaviour trials and decreased after two consecutive problem behaviour trials.					
Starting from 30s wait interval, a phone and headphones were placed within the participant's reach and the participant was allowed to listen to music while waiting.					
Total					

Appendix J

FCT Phase 4 Data Collection and Procedural Integrity Form

FCT Datasheet

Date : _____ Stage : Phase 4

Researcher : _____ Participant : _____

Circle one : Primary / IOA Session : _____

Direction : Condition for the trial will be pre-determined prior to the sessions. **Imm** for immediate trials, **Delayed** for delayed trials and **Denial** for denied trials.
For ***precursor behaviour*** column, mark ✓ if participant engages in precursor behaviour. If not, circle X.

Trials #	Condition	Activity Requested	Alternate Reinforcer Offered	Precursor Behaviour	Verbal Redirection	Response Blocking	Problem Behaviour	Comment
1	Imm Delayed Denial	Sensory Art		✓ ×	✓ ×	✓ ×	✓ ×	
2	Imm Delayed Denial	Sensory Art		✓ ×	✓ ×	✓ ×	✓ ×	
3	Imm Delayed Denial	Sensory Art		✓ ×	✓ ×	✓ ×	✓ ×	
4	Imm Delayed Denial	Sensory Art		✓ ×	✓ ×	✓ ×	✓ ×	
5	Imm Delayed Denial	Sensory Art		✓ ×	✓ ×	✓ ×	✓ ×	

Item	Fidelity Checklist	Trial (✓ if completed or N/A, X if not completed)				
		1	2	3	4	5
1	The preferred items are placed in bins across the room.					
2	Participant is seated at the table facing the researcher.					
3	The picture-based communication sheet is placed on the table within participant's reach.					
4	For immediate trials, immediate access to the reinforcer is given for about 30 second upon emission of FCR.					
5	For delayed trials, access to the reinforcer is withheld until terminal delay interval elapsed without any engagement in problem behaviour.					
6	For denial trials, the participant's access to the reinforcer is denied and an alternate activity/item is offered.					
7	Participant is offered with another alternate reinforcer if they do not accept the initial one.					
8	The denied reinforcer is withdrawn for the rest of the trial.					
9	When the participant engaged in problem behaviour during trials, researcher blocked and said, "Please sit down" or "Be calm."					
	Total					