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**Laying the Tracks: Investigating the Potential Benefits for Autistic
Children of a Model Railway Initiative**

A thesis

submitted in fulfilment

of the requirements for the degree

of

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Abstract

This study described a model railway programme in terms of its benefits for autistic children and their families/communities. A non-experimental mixed-method design was conducted, in which an observation schedule was designed to determine whether behaviours which are associated with language development were facilitated by the programme. Interviews with parents/caregivers were conducted to collect qualitative data about the programme, to better understand how it is perceived by visitors and what draws them to attend. Individual case studies with children and their parents/caregivers were done to build a clearer picture of what can be seen at an individual level. Finally, a focus group was arranged with members of the railway modeller's club to find out their point of view and broaden the qualitative scope of the data. Findings suggest potential utility in this programme for autistic children and future research implications are discussed.

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Literature Review

Introduction

Autism Spectrum Disorder (ASD) is characterised by difficulties in social and communicative dimensions; limited, inflexible, and repetitive interests, routines, and behavioural chains; and hyper- or hyposensitivity to sensory stimuli. ASD is a spectrum, and autistic people may exhibit differing degrees of ability across these domains, such that the level of support an individual requires varies. ASD is often comorbid with intellectual disabilities, and these individuals often require extensive support (World Health Organization, 2021). While some of these symptoms, such as those in the socio-communicative domain are generally observed as part of the typical early developmental stages in infancy, typically developing children will go on to acquire more complex behaviour skills, and a wider range of interests and behavioural patterns. Deviation from this developmental trajectory is often an early indicator of ASD (Fein et al., 2021). The symptoms of ASD in the broad sense impede the acquisition of important skills, so treatments for autistic children mostly target skill acquisition. ASD displays what is referred to in the developmental psychology literature as “homotypic continuity,” meaning behaviours predict themselves over time. In general, this early presence of socio-communicative difficulties predicts their presence later at different stages of development. Approximately 1 in 100 New Zealanders have a diagnosis of ASD, a prevalence which NZ may not currently be resourced to support (Thabrew & Eggleston, 2018). The symptomatology of ASD is generally accepted to have neurological and biological bases, and research on the treatment of ASD takes place in various fields such as behavioural psychology, cognitive psychology, developmental psychology and pharmacology (Fein et al., 2021). The scope of this thesis will be situated in behavioural psychology, though papers outside of this field are featured and will be referred

to through a behavioural lens. Throughout this thesis, children with a diagnosis of ASD will be referred to with the identity-first nomenclature “autistic children.”

The predominant treatment approaches of early intervention for skill acquisition in autistic children are based upon the principles of Applied Behaviour Analysis (ABA), due to its substantive empirically-validated research base (Fein et al., 2021; Sundberg & Michael, 2001; Vismara & Rogers, 2010). The basic principle which guides ABA is that all behaviour develops from and is maintained by the consequences which follow them. ABA grew out of the experimental analysis of behaviour (EAB) in the 1950s and 60s, when behavioural scientists began applying the methods and philosophies of EAB in the lab with human subjects. For EAB, behaviour is the activity of an organism as it interacts with its environment. EAB describes two kinds of behaviour, and thereby two ways in which to effect behavioural change: respondent behaviour and operant behaviour. Respondent behaviour describes an organism’s reflexive response to an antecedent stimulus; oftentimes the organism is genetically predisposed to this reflex. Respondent conditioning is the learning of a new respondent behaviour by the pairing of an unconditioned stimulus (US / something which already elicits the reflex) and a neutral stimulus (NS / which does not occasion the reflex). After repeated presentation of the US and the NS, eventually the NS can elicit the reflex by itself, thus it has become a conditioned stimulus, establishing a conditioned response. Operant behaviour is defined as behaviours which are shaped by the consequences that succeed them in an environmental context. A set of environmental stimuli are present before the behaviour, an organism behaves, and then a consequence happens subsequent to this behaviour. An operant behaviour can have a varied topography, meaning it doesn’t always look the same a second time. Operant conditioning is a process by which a particular consequence follows a behaviour closely in time in the presence of a specific set of environmental stimuli. The consequences determine whether a behaviour is more (reinforced)

or less (punished) likely to occur in that specific environment again in the future (Cooper et al., 2020b). There are a few key terms in operant contingencies that are necessary to know: a discriminative stimulus is a stimulus which has had a particular behaviour reinforced in its presence, but not its absence. This behaviour is now under stimulus control (Cooper et al., 2020c).

The purpose of ABA is to effect changes in behaviours which improve the day-to-day life of an individual and their community. ABA practitioners measure behaviour directly, so the phenomena that practitioners and researchers study must be observable and reliably measurable (i.e., unambiguous) by other practitioners. Descriptions of behaviours and the methods used to change them should therefore be technological, such that any reader of the research trained in ABA could replicate the study and find similar results. As well, these technologies must be conceptually systematic to the principles of ABA. The function of the behaviour must be established, and control of the behaviour must be demonstrated to the greatest possible extent, depending on how ethical it is to produce occurrences of the target behaviour. ABA's goals in application differ from some other experimental procedures, in that the theoretical importance of the variables are less important than their ability to alter behaviour in a way beneficial to the individual (Cooper et al., 2020b).

From a behavioural perspective, ASD can be seen as a cluster of skill deficits in the areas of social skills and communication, along with an atypical response to certain environmental stimuli (Novak & Pelaez, 2011). While it must be noted that ASD is phenotypically diverse and that a not inconsiderable number of children diagnosed with ASD go on to develop functional social and communication skills, there is a significant cohort whose symptoms may inhibit the development of these skills in a typical environment (Fein et al., 2021). The absence of these skills and the presence of maladaptive behaviours in their place, such as tantrums, can impact the child into their adult life. They may find it difficult to

form social relationships, have trouble integrating into their communities, and may find themselves significantly dependent on parents/caregivers. Approximately 31% of autistic individuals will have a co-morbid diagnosis of Intellectual Disability (ID) (Fein et al., 2021). ID describes significant impairments in cognitive and adaptive functioning, with individuals receiving Intelligence Quotient (IQ) measures of 70 or lower. Comorbidity of ID is associated with greater symptom severity, including significant impairment in the development of adaptive skills, making independent living impossible, and functional language skills, which some autistic people may never develop (Peters-Scheffer et al., 2016). It is therefore crucial to support the behavioural development of this cohort.

One of the main areas of focus for autistic children in ABA is verbal behaviour (VB). This is often a key area in which autistic children struggle (Sundberg, 2020). Primarily based on the work of B.F. Skinner, the behavioural account of VB considers two important properties: the form of a verbal response (e.g., spoken, written, signed) and the function (the specific outcome the VB will elicit). The primary distinction between VB and other forms of behaviour is that VB is inherently socially mediated, by definition requiring two social roles for a verbal episode: a speaker and a listener (with the exception being thought, where a speaker and a listener are the same person). The speaker emits a verbal response while the listener responds in a way which has been conditioned to reinforce the behaviour of the speaker. The full range of these behaviours that an individual is able to perform is called a “verbal repertoire” (Sundberg, 2020). As mentioned earlier, the “verbal” in “verbal repertoire” is not interchangeable with “vocal” (though the form of a VB can of course be vocal), and the “verbal repertoire” includes behaviours such as gestures or written language. Typically developing children attend more to social stimuli than do autistic children. Because of this and the inherent sociality of VB, autistic children have fewer opportunities to develop verbal behaviour skills (Newsom, 2011). In fact, the distinct difficulty of the development of

VB skills for autistic children could be seen as the defining characteristic of ASD from a behavioural perspective. Autistic children may struggle with some of the typical behavioural patterns of the speaker and listener roles, exhibiting fewer verbal initiations, atypical speech prosody, failure to allow for turn-taking, and reduced preservation of conversation topic (R. L. Koegel et al., 1995). Autistic children also tend to have deficits in listener skills. A particularly relevant class of VBs known in the literature as “mands” are useful to describe listener skill deficits. In non-technical terms, mands can be thought of as how a speaker requests something from a listener. Here, the speaker’s behaviour comes from a history of associating these kinds of utterances with access to a specific reinforcer from the listener, ergo the listener’s behaviour acts as a reinforcer for the speaker’s VB. If the listener’s behaviour fails to reinforce the speaker’s behaviour, e.g. when an autistic child does not respond to another child’s request to play, then verbal interaction from others becomes less likely to occur (Lorah et al., 2014).

Current Learning Interventions

Comprehensive ABA Interventions

There is a distinction to be made between two kinds of behavioural treatments: comprehensive ABA interventions and focused ABA interventions. Comprehensive ABA interventions are those which focus on improvements in a broad range of general metrics, such as language skills and social functioning. They may also indirectly lead to increases on measures of intelligence such as IQ. These treatment plans are individualised depending on the profile of the individual derived from a criterion-based assessment and are generally continued on timelines which can last for as much as a year or more. These treatments make use of repeated delivery of small behavioural contingencies to target the development of functional skills. Focused ABA interventions are designed to target specific skills and increase adaptive and functional behaviours, such as teaching an autistic child how to dress

on their own, and they are also used to decelerate problem behaviours such as self-injury (Hagopian et al., 2015). When choosing which behaviours to target for a focused ABA intervention, there are a few critical behaviour classes which may become focal to a treatment plan.

Early Intensive Behavioural Interventions and Discrete Trial Teaching

Among the most prevalently practiced comprehensive interventions for autistic children are Early Intensive Behavioural Interventions (EIBIs). As the name suggests, these are intensive, usually one-on-one interventions which are administered anywhere from 15-50 hours a week, sometimes for a year or more. The goal of EIBI is to teach important developmental skills to children as early as possible to support long-term skill acquisition (Lovaas, 1987; Rodgers et al., 2021) One of the primary strategies utilised particularly when beginning EIBI is Discrete Trial Teaching (DTT). In DTT, a teacher looks to maximise control over an environment, so that antecedents and consequences can be optimised to teach a target behaviour. The teacher cues a particular response (usually with a verbal prompt) and the learner either responds or does not. If the response is incorrect or does not occur at all, the teacher continues to prompt, and reinforcement is withheld. If the learner emits the target response, they are rewarded with a preferred stimulus. The inter-trial interval (ITI)—a brief pause between the completed trial and the next one—then elapses (Ghezzi, 2007).

One study foundational to EIBI was O. Ivar Lovaas' (1987). Thirty-eight children aged 46 months or younger with a diagnosis of ASD were divided into even experimental and control groups. The experimental group received 40 hours a week of an intensive ABA programme applying the principles of operant learning, while the control group received the same treatment but at only 10 hours a week. Both groups received this treatment for two years. The mental ages (MA) of the children were compared pre- and post-treatment (between the ages of 6 and 7), measuring intelligence quotient (IQ) with various tests

depending on the child's developmental stage at the discretion of the examiner. The findings showed statistically significant between-group differences in post-test MA scores, suggesting that comprehensive EIBI produced greater increases in MA than the less intensive treatment EIBI package. There are issues with these findings however. The practitioners in Lovaas' paper made use of aversives for incorrect responding, striking the children on their thighs, a procedure unethical by today's standards. Lovaas himself admits in the same paper that it would be difficult for other researchers to replicate the conditions and therefore, the findings, of this research (Lovaas, 1987). Furthermore, the aggregated data analysis in Lovaas' paper also obscures the intervention's individual effects, and other researchers have found that language acquisition rates following DTT can be heterogenous (Kasari et al., 2023). DTT is often criticised for producing limited generalisation and rote behaviours.

Because of the highly controlled environment DTT takes place in, behaviours learnt through DTT may not be emitted in the absence of the teacher's cues and may not generalise to novel environments (T. Smith, 2001). An issue commonly encountered in behavioural interventions with autistic children is the development of prompt dependent behaviours. Prompt dependency is when a behaviour comes under the stimulus control of a cue from a teacher, in other words, the child does not initiate the behaviour, instead they will only do it when prompted to. Ideally, the behaviour should instead be under the stimulus control of the environmental stimulus which the behaviour interacts with to produce a consequence. For example, a dark room should be the discriminative stimulus for turning on a light switch, not a verbal prompt to "turn on the light" from a teacher. This is a serious issue, because it does not increase the independence of the autistic child, and in fact the removal of prompts may not result in the persistence of the problem behaviours the prompted behaviour was taught to replace. There are methods for preventing or treating prompt dependency, such as a gradual fading of the prompt by diminishing the salience of the cue (Weyman et al., 2024).

A similar drawback of DTT is that it tends not to increase rates of initiations in autistic children, and in fact may reinforce not initiating (Freeman et al. 2024). Initiation is when an individual begins a social interaction themselves, be it verbally or nonverbally. L. K. Koegel et al. (2016) found that autistic children who initiated more frequently had better outcomes in developing communication skills over time. Self-management describes an individual's control over their behaviours in the absence of an external moderator. Teaching this skill to autistic children can be helpful for managing on-task behaviour and reducing disruptive behaviours, for example in a classroom setting (L. K. Koegel et al., 2016).

There are also situations where DTT performs less efficiently than other methodologies for certain behaviours. For example, Mand Training has been demonstrated to produce higher rates of independent (in the absence of teacher cues) manding—a class of verbal operant where the function is the delivery or removal of a stimulus by a listener (Sundberg, 2020)—than DTT (Jennett et al., 2008). Bravo and Schwartz (2022) investigated object manipulation in autistic children using contingent imitation—where a teacher imitates the motor behaviour of the student—and DTT found minimal effects on motor imitation with objects, and that higher pre-intervention motor skills predicted better post-intervention results. Other studies have augmented DTT with other interventions. Dixon et al. (2018) attempted to bring extended intraverbal chains under audience stimulus control. This was done in the context of a classroom “show-and-tell” social presentation, by using DTT and the PEAK Direct Training Module to reinforce extended intraverbal response chains. Their results suggest that extended intraverbal behaviour in autistic children can be brought under stimulus control.

Modern EIBI has progressed past a primary reliance on DTT, incorporating more naturalistic techniques of teaching, including child-led and incidental teaching methods. Generally speaking, EIBIs have a solid empirical foundation (Rogers et al, 2021). Granted,

translating evidence-based interventions into applied settings often comes with practical challenges, since the high staff-to-child ratio and level of practitioner skill seen in the lab is difficult to obtain in service settings (Vivanti et al., 2014). Perry et al. (2008) conducted a large-scale efficacy review of a community-based Intensive Behavioural Intervention (IBI) programme rolled out in the province of Ontario, Canada, and found statistically and clinically significant increases in cognitive performance. Notably, there were increases on the Socialization and Communication domains of the Vineland Adaptive Behaviours Scale (VABS). These findings are significant in supporting the efficacy of EIBIs outside of a lab setting. Magiati et al. (2010) found in a follow up study on a cohort of children who had received EIBI, both in home settings and not, that while scores across cognitive, language and adaptive behaviour domains had increased significantly, the rates at which these skills were being acquired were below that of typically developing peers. Gains in functional language skills were seen in follow up results. A meta-analysis of 10 studies which included a total of 491 participants compared the effectiveness of EIBI to treatment as usual for preschool-aged autistic children. The children who received EIBI showed greater improvement on the VABS after two years and in intelligence quotient (IQ) after one year (with further improvements after two years) than children who received treatment as usual (Rogers et al., 2021).

Eckes et al. (2023) examined 11 studies, the majority of which used EIBIs, while a few used similar comprehensive programmes such as the Verbal Behaviour Approach, in a meta-analysis. Studies were selected where the control group either received treatment as usual (TAU) or minimal to no treatment. The authors found moderate and small effect sizes respectively for comprehensive programmes in increasing intellectual functioning and adaptive behaviours when compared to controls. This meta-analysis did not find significant differences between experimental and control groups for language abilities, symptom severity

and parental stress, however this may be due to the conservative inclusion criteria for studies. The authors limited the studies analysed to those which included control groups, such as those with randomised controlled trials (RCTs). In ABA, research is generally done with single-case studies, an atypical approach to other fields of psychology. This is because it is an assumption in ABA is that behaviour is an individual phenomenon, and therefore the aggregation of data from large groups is seen to obscure the effects of a given treatment on the individual (Cooper et al., 2020a).

An economic cost-benefit analysis of EIBI for autistic children was undertaken by Jacobson et al. (1998), which suggested that (given some assumptions) the delivery of EIBI could save families and individuals anywhere from \$187,000 to \$1,082,000 United States Dollars (in 1998) when the long term costs of education support and adult residential expenses are accounted for. When this is considered alongside EIBI's efficacy for facilitating skill learning, this lends support for EIBI as a primary intervention plan. However, the sheer scope, intensity and resource costliness of the programme also makes it impractical for most families if it is not government funded, as the short term financial costs to initiate treatment may be prohibitive, as well as the long term cost of continuing the programme long enough for it to be efficacious (Jacobson et al., 1998; Vismara & Rogers, 2010).

The Denver Model and the Early Start Denver Model

The Denver Model (DM) is a naturalistic parent-mediated intervention for autistic children. Primarily developmental in philosophy, the DM is multidisciplinary, drawing on other fields such as ABA and Neuroscience. It is naturalistic in that it is focused on teaching operant contingencies in the context of the child's everyday activities, rather than in contrived settings. Generally speaking, the idea of the DM is recognising that physical social interactions such as imitation are linked to the development of social skills, and it can be individualised to the pre-treatment skill levels of the child. (Rogers et al., 2006; Vismara &

Rogers, 2010; Vivanti et al., 2017). Rogers et al. (2006) found the DM to be efficacious for increasing the vocabulary of some children with mild to moderate ASD symptoms on the Autism Diagnostic Observation Scale aged between 29-57 months, when delivered as a treatment package by professionals in a clinical setting and accompanied by parent-administered treatment at home.

The Early Start Denver Model (ESDM) is an adapted version of the DM for infants and toddlers. The early intervention nature of the ESDM is predicated on treatment effects being more pronounced at an earlier age, and this was observed with regard to language in the ESDM as an intervention by Vivanti and Disbanayake (2016) where they found a smaller language development delay in autistic children aged between 18-48 months compared to autistic children aged between 48-62 months. The authors did not however, find a significant difference between age groups for non-verbal skills. From this paper, it is unclear whether the authors mean “verbal” in this context as it is understood in ABA, or whether non-verbal here is meant in common parlance as equivalent to vocal utterances. Skinner’s definition of VB includes forms which are non-vocal, so this is an important distinction to make in the context of ABA (Sundberg, 2020).

The ESDM has been linked to improvements in IQ scores and improved developmental progress in autistic children when implemented at a 1:1 teacher-student ratio (Dawson et al., 2010), but these findings have also been observed in laboratory settings (Contaldo et al., 2020), in larger preschool settings with a larger teacher-student ratio (Vivanti et al., 2014), and in daycare settings where the ESDM is delivered to children in groups (Eapen et al., 2013). The pre-treatment variables affecting outcomes for children receiving the ESDM appear to be heterogeneous (Contaldo et al., 2020; Vivanti et al., 2014), and the effectiveness of the ESDM may be moderated by factors such as pre-treatment severity of ASD symptoms, as well as use of social-communicative gestures and joint attention skills

(Contaldo et al., 2020). Clinical research by Laister et al. (2021) also found that lower levels of pre-intervention social-communicative gesture use was a predictor of language acquisition in autistic children receiving treatment using the ESDM. Vismara et al. (2013) trained 24 community-based early intervention practitioners in the delivery of the ESDM using a four-day workshop, in order that the ESDM could be delivered to families outside of the lab setting. Though the professionals could perform the ESDM procedures at 80% fidelity or better by the end of the workshop, only 46% of participants submitted follow-up data. While these 46% were continuing to deliver the ESDM at a high fidelity, the authors suppose that other barriers to implementation in a community-based setting may prevent practitioners from going on to use the ESDM. There are also questions about whether 80% fidelity is a suitable threshold for effective treatment implementation. Eapen et al. (2013) investigated the ESDM in a community-based setting where treatment was delivered to children in a group. Their findings continued to demonstrate the ESDM's efficacy for improving results of autistic children in domains of language and communication, indicating that group delivery may be a viable economic solution in resource-constrained environments.

Pivotal Behaviour

Pivotal behaviours lead to response generalisation in untrained behaviours. These pivotal behaviours are: motivation, responsivity to multiple cues, self-management, and self-initiations. These behaviours lead to gains in social and communication skills. L. K. Koegel et al. (2016) provide us with a negatively defined account of motivation, describing a motivational deficit as being a reduced frequency of initiated responding. This is tied to the account of "learned helplessness," where an individual has learned that consequences are independent of their behaviour, leading them to respond less frequently. This can be seen playing out when autistic children attempt social interactions. Due to social skills being a challenging learning area for autistic children, attempts at socialising with peers may

repeatedly be unsuccessful, and so this behaviour is not reinforced and is performed far less frequently. Motivation is therefore important to target. Autistic children may exhibit “overselective responding”, also referred to as “stimulus overselectivity”, where responding is only in relation to one cue from a complex stimulus, such as identifying a person solely by their glasses. (Rieth et al., 2015). In Rieth, et al.’s (2015) study of 42 autistic children (either diagnosed or educationally identified as autistic), they found the prevalence of stimulus overselectivity in their sample to be 19%. Typically developing children are able to adapt to multiple cues—which may change from object to object within a stimulus class—identifying which cues are more relevant than others in a given situation. To return to the glasses example used by Rieth, et al. (2015), other cues related to a person’s physicality, such as their height, their facial features, or the shape of their body, are more likely to remain relatively constant and while one attribute may describe various people, these specific cues in combination become more reliable identifiers than an article of clothing which can either be changed or removed. This requires the teaching of the pivotal behaviour “responsivity to multiple cues.”

Pivotal Response Treatment

Pivotal Response Treatment (PRT) is an ABA-based intervention developed by Robert L. Koegel and Lynn Kern Koegel. It aims to target pivotal responses instead of discrete behaviours. PRT is a set of principles rather than a procedural intervention. These principles assert that the environment should be optimized by making delivery of treatment early, intense and frequent within a natural environment and with family involvement in both the planning and implementing stages (Renshaw & Kuriakose, 2011).

Verschuur et al. (2014) examined the literature on PRT to determine the range of skills targeted with PRT and its efficacy for skill acquisition in autistic children as well as their caregivers. They also assessed the strength of evidence, identified any research limitations,

and made suggestions for future research. Across the 43 studies assessed, the findings suggest that PRT is effective at teaching children self-initiation, though findings were mixed and PRT was not efficacious for some children. The other pivotal skills central to PRT had not been studied in detail across the literature, with one study investigating motivation while no studies investigated responsivity to multiple cues or self-management. PRT seems to facilitate play, language, and communication skills acquisition indirectly.

A meta-analysis of PRT by Uljarević et al. (2022) supports PRT as an intervention for the development of language and communication skills in autistic children, but evidence for improvements in other developmental areas is weaker. Studies on other non-language areas such as ASD severity and adaptive functioning are limited, so it is difficult to make conclusions based on current research.

Positive growth was also found in areas of language and communication in a study by I. M. Smith et al. (2010) which examined an intervention where parents were trained to use Pivotal Response Treatment (PRT) with their autistic children in naturalistic settings (that is, in the home or community settings such as day-care centres, ergo outside of a lab).

Peer mediated PRT (PM-PRT) is an adaptation of PRT where typically developing peers are trained in the delivery role usually occupied by parents/caregivers or professionals, and the interventions tend to focus on social skills (Boudreau et al., 2015). Examining the literature on PM-PRT up until that point, Boudreau et al. (2015) evaluated PM-PRT as a promising approach given the brevity of treatment (seven 20-minute sessions across two weeks) and the importance of social skills as a pivotal behaviour area, but felt the paucity of literature (they only found five studies at the time) disqualified it from the label of “evidence based practice.”

PRT has potential as a cost-effective evidence-based practice for rural practitioners. Dahiya et al. (2021) collected data on professionals who were working in rural areas with

autistic children, who attended a one-day PRT workshop and followed up with a much smaller three-day training workshop. The professionals who attended the one-day workshop reported increased confidence and decreased levels of stress. Following the three-day workshop, results demonstrated that two of the three professionals examined were able to implement PRT with variations in fidelity across the techniques. This finding that fidelity was maintained to varying degrees sufficient for effective treatment is consistent with those of (Boudreau et al., 2015). It may be that continued training is required for maintenance of optimal delivery.

Focused ABA Interventions

Behavioural Cusps

Behaviour cusps are a concept defined as a behavioural change which allows an organism broader access to a new range of environments and contingencies. This increases the learning of new behaviours in new behaviour classes and more efficient variations on older behaviours. Behaviour cusps lead to interactions with new reinforcers and punishers, which increase and reduce the frequency of a behaviour or stimulus interaction respectively (Twyman, 2011). Twyman (2011) used the example of “learning to walk,” which increases the speed at which a child can move through environments, while also opening up new forms of social play with other children such as “tag.”

Joint Attention

Joint attention (JA) is where the orientation of the gaze of one person is under the stimulus control of another’s (Holth, 2011). JA is important for the facilitation of language development, both vocal and gestural (Kasari et al., 2008). Lower rates of JA have been observed in autistic children compared to typically developing children (Jordan, 2003; Siller & Sigman, 2008). Whalen and Schreibman (2003) use a definition of JA describing it as attention coordinated on an object and another person in a social context. Historically there

has been limited research in behavioural psychology on JA, as it is rooted in cognitive language and the manipulable variables involved in teaching JA skills are unclear to behavioural researchers (Holth, 2011). Methods for increasing rates of JA have been investigated, as autistic children who respond more to bids for JA are expected to gain language skills faster than those who are less responsive (Siller & Sigman, 2008). A study by Whalen & Schreibman (2003) compared autistic children with typically developing children. Behaviour modification techniques, such as components of DTT, were used to teach the children to respond to the experimenter's JA initiations, with toys used as preferred stimuli as part of the behavioural contingencies being taught. The autistic children made gains in JA responding post-treatment, though rates of JA responding were lower than those observed in the typically developing cohort. Using a combination of developmental and behavioural approaches, Kasari, et al. (2006) investigated targeted JA and symbolic play interventions. Children in the intervention group exhibited greater rates of JA skills such as responding to adult-initiated JA, as well as initiating JA contingencies with adults, and generalised these skills from lab settings with an experimenter to their caregivers. Longitudinal maintenance of these skills however cannot be determined from this study. Investigating JA and symbolic play in naturalistic settings, Lawton & Kasari (2012) trained preschool teachers in select strategies from the Joint Attention and Symbolic Play Engagement Regulation (JASPER) treatment approach. In the experimental condition teacher/student dyads were created with preschool teachers who had the JASPER training and 3-5 year-old autistic children. The control group dyads simply received standard care for this environment. Improvements in child-initiated JA were demonstrated, but improvements weren't as pronounced as previous lab environment studies. Chang et al. (2016) also found JASPER to increase rates of joint attention amongst preschool-aged autistic children, and also found high treatment fidelity even when implemented by teachers and paraprofessionals outside of laboratory settings.

Chohan and Jones (2019) successfully taught a group of 4-5 year-old autistic children to initiate JA with a smile expression coordinated with gaze shifting, though the authors reflect that it is unclear whether the taught smile correlated to social motivation for the child. Kasari et al. (2023) conducted a randomised control trial with 164 autistic children and significant verbal development delay, comparing DTT with JASPER. The results showed that the two treatments were similarly efficacious, however not all children acquired verbal skills from either intervention, and as the data in this study was aggregated, the characteristics of these children and the limitations of the treatments are unclear.

Play

Autistic children are often observed engaging in repetitive and limited forms of object play. For example, they might line up toy animals in a specific pattern, or spin the wheels of toy cars rather than play with them creatively as a typically developing child might, exhibiting very little exploratory motor behaviours with the toys (Charlop et al., 2018a; Fein et al., 2021). These skill deficits leave them limited opportunities to encounter the contingencies which lead to acquiring new skills through play. Researchers and practitioners have observed that play is an important way that children develop motor, sensorimotor, social, and language skills. Ordinarily, play can create naturally reinforcing contexts where children can learn the previously mentioned skills, however this is an area where autistic children tend to display developmental abnormalities and skill deficits (Charlop et al., 2018b; Jordan, 2003). On a much simpler level, play is an important behaviour to target due to its potential to provide a route through which socialisation with peers can develop, leading to the skills which facilitate friendship bonding, but autistic children may not find the social aspects of play reinforcing. Play fits the description of a behavioural cusp, creating scenarios whereby new response contingencies can form. It is a particularly important area to target because it serves as a cusp to social behaviours, which may have important implications

further in an individual's lifespan, as they may be crucial in participating in school and other educational contexts, and later on, social contexts such as workplaces for customer-facing jobs or roles where inter- or intra- department communication is necessary.

Interventions for Play

Various methods have been employed to teach children to vary their play behaviours. Lag reinforcement schedules, whereby responding is only reinforced if it differs from x number of previous responses, have been studied to investigate their efficacy for teaching variable responding during play in autistic children. While increases in variability have been observed, variability may not generalise outside of treatment settings, and may not effectively generalise to novel stimuli (Ivy et al., 2019; Napolitano et al., 2010). Thomas and Smith (2004) found that the use of an intervention utilising play skill teaching and behaviour mirroring with an adult instructor may have been able to increase what the authors describe as "functional play" in autistic children, though it may be the case that instructive events outside of the experiment, such as social play scenarios natural to childcare settings, contributed to this observed increase. Akers et al. (2018) used activity schedules and embedded scripts (which were later faded) to successfully teach autistic children how to play the social game "hide-and-seek." Some of the children were noted to emit contextually relevant verbal responses. Some methodologies, such as play therapy, may produce improved social skills in certain social environments such as classrooms, but may only be appropriate for children already possessing certain verbal repertoires (Müller & Donley, 2019).

In a study investigating the practicality of conducting a functional behaviour assessment (FBA) in a school environment to determine the function of problem behaviours, McDonald et al. (2012) found play behaviours reduced stereotyped behaviour in an autistic child in a playground setting. This reduced episodes of aggression in the child, which was

being maintained by understimulation (i.e., boredom). Camacho et al. (2014) taught play to a child with autism in an experiment looking to test the practicality of carrying out an FBA in a school setting. The aim was to replace the child's problem behaviours, which involved physical contact with another child and non-engagement with classroom activities. The intervention phase of this experiment involved teaching the child to engage with a preferred activity, in this case playing on a tricycle. For this, a teacher instructed groups of children, which included the target child, to play with the tricycle. The intervention resulted in a significant increase in play behaviour compared to baseline conditions. The play behaviour in the playground also saw an increase in verbal utterances and a reduction in problem behaviours compared to non-intervention conditions.

Imitation

Imitation is a skill which typically emerges in infancy which serves both a learning and social function. Face-to-face imitative behaviour with caregivers is where infants begin to learn communicative and affective responses, through imitating their caregiver's vocal sounds and facial expressions. Imitation in autistic children has been correlated with vocalisation—those who imitate more also exhibit greater rates of vocalisation (Ingersoll, 2008). Reciprocal Imitation Training (RIT) is a naturalistic behavioural method designed to teach young children with autism how to imitate the behaviour of adults. This process incorporates toys. (Ingersoll, 2008). RIT may be beneficial in improving communicative behaviour rates in autistic children. Research by Ingersoll and Lalonde (2010) found evidence suggesting the inclusion of gesture imitation training as part of an RIT package may further improve vocal behaviour in some autistic children. It is not clear why exactly this might be, but the authors suggest there is an inherent communicative aspect to gestural imitation which is not necessarily always present in object imitation. The object in the object imitation condition also may have acted as a distractor, blocking the child from attending to the

teacher's other physical behaviour. This may relate back to a tendency towards "overselective responding" which is often seen in autistic children (L. K. Koegel et al., 2016).

Parent Mediated Interventions

As previously noted, NZ appears to be under-resourced when it comes to providing ABA services, and access to these services isn't always practical for families (Plessas et al., 2019; Thabrew & Eggleston, 2018). What then can be done in the interim? Parent-mediated ABA interventions have been associated with gains in the socialisation domain of the VABS in autistic children when compared to those receiving paraprofessional-mediated treatment, though both groups showed improvements on this scale, as well as on the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) (Sneed et al., 2023).

Incidental teaching is another method which has been used to teach speech to autistic children who are not developing verbal behaviour at a typical pace. In group home settings, such as those investigated by McGee et al. (1983), incidental teaching is economic, as carers can implement it while attending to other necessary tasks around the home. Parent-mediated intervention models are not without their pitfalls, however. Treatment fidelity may not remain at the necessary levels, as mitigating factors such as work and family life (such as other children) impact parental capacity to deliver treatment at the recommended levels (Drew et al., 2002).

In a review of articles investigating parent-mediated behaviour interventions for autistic children which used randomised control trials (RCTs), Oono et al. (2013) concluded that autistic children may show gains in expressive language and language comprehension skills after delivery of a parent-mediated behavioural intervention. Improvement in parent-child interactions in observed interaction was found to have the strongest relationship to increases in joint attention of the variables noted across studies. While the delivery of therapeutic experiences in the child's natural environment is a strength of parent-mediated

behavioural interventions, it makes it difficult to determine duration and intensity of intervention delivery, which was a key outcome predictor in Lovaas' (1987) paper. An interesting finding of this meta-analysis was that, while results were variable, a few studies showed children with lower pre-intervention skills scores compared to other children tested made greater gains in domains such as language skills post-test than children with higher-functioning skills. The authors point out that studies tend to find that higher functioning children with autism tend to obtain greater gains. Variables controlling these gains were not observable from this meta-analysis. From this meta-analysis, the authors recommended that service providers consider service packages which make use of parent-mediated interventions in combination with their own services. Treatment packages should be individualised, reflecting the variability of findings across studies. The authors also noted no significant reduction in levels of parental "stress," and this typically was not an outcome examined by the studies in the meta-analysis. Whether training on and delivery of parent-mediated behavioural interventions increases levels of stress amongst parents should be considered a factor as to whether these programmes are efficacious or not.

Parents of autistic children have long been observed to report elevated levels of stress compared to parents of typically developing children. Parental stress was measured in Tripathi et al. (2022), observing that self-reported parental stress levels decreased immediately post-treatment, but increased with the re-emergence of child problem behaviours, though not to clinically significant levels. Parental stress may relate to the management of problem behaviours which on the extreme end may involve tantrums and self-injury and cognitive impairments. Some autistic children have a high dependency on parents for day-to-day functioning. Parents may feel unprepared may not feel that they are sufficiently knowledgeable in raising autistic children, particularly if they exhibit high rates

of problem behaviour, and may lack the financial resources to afford best practice care (Moes, 1995).

PEERS

The Program for the Evaluation and Enrichment of Social Skills (PEERS) is a parent-mediated intervention focused on teenagers. It is not explicitly for teenagers with ASD, though the bulk of the research has focused on this cohort. Parent and teenager groups meet separately. The sessions focus on social behaviour skills such as conversation initiation and termination, functional responding to peer rejection such as bullying and arguing, and participating in peer group gatherings (Laugeson & Frankel, 2010).

Wyman and Claro (2020) investigated PEERS in a school setting, rather than as part of a clinical outpatient group model. Their subjects were 63 students with either ASD or an Intellectual Disability aged between 15-21 years. Both groups showed improvements in social skills knowledge, however the ASD group tended to have more difficulty applying this to social settings outside of the programme.

Tripathi et al. (2022) investigated the maintenance of treatment outcomes for children receiving PEERS and their families in a 1–5 year period following cessation of treatment. The children in this study were between 4-6 years old and had a diagnosis of ASD, though they were selected based on adequate expressive language skills. Post-treatment information was completed by parents. Improvements in social skills were observed post-treatment and were maintained over the 1-5 year follow up period. The children in the study were also reported to be attending “play dates” with peers at rates comparable to typically developing children. However they also found that participants did not continue to gain new social skills relevant to their changing social contexts as they progressed through the school system and social demands changed and increased, suggesting that continued treatment for autistic children may be necessary.

Qualitative methods were used by Honan et al. (2023) to determine the social validity of an adapted PEERS programme. Eight young adults with a diagnosis of ASD and/or mild intellectual disability and one of their caregivers ($n = 8$) participated in an adapted version of the PEERS programme, where the caregivers and three trained PEERS coaches and four staff participated in four 2-hour sessions across the 16-week period instead of weekly 90-minute sessions. Subsequently, three separate 45-minute focus groups (one for each cohort) took place, discussing themes on programme acceptability, feasibility, participant experiences and perceptions of outcomes. The authors describe the overall theme of their qualitative findings as “PEERS is challenging, but worthwhile.” Some of these challenges are worth noting. The practicalities related to parents working around work schedules, as well as transport logistics in larger cities (this study took place in Sydney, Australia). Despite reporting feeling overwhelmed by some of the topics covered in the sessions (notably dating), participants generally indicated that the programme was acceptable.

A key limitation of PEERS for some participants is that social skill gains from PEERS seem to require a prerequisite level of verbal repertoire that not every child or young person with ASD necessarily possesses (Honan et al., 2023). Chang et al. (2014) found that higher baseline reported social skills was a predictor for greater improvement following PEERS. They also found that lower pre-treatment self-perceptions of social functioning also predicted gains in social skills following PEERS.

LEGO Therapy

LEGO Therapy is an intervention for autistic children which makes use of the children’s potential interests in LEGO construction toys to teach social and communicative skills. The choice of LEGO as the central topic of the intervention was drawn from an observation of LeGoff (2004), who saw two of their autistic learners interact with one another in passing over LEGO they had independently brought to the clinic, despite displaying little previous

social motivation. Sessions with the two children utilising LEGO later developed into larger group sessions after other children showed interest. Child-preferred materials are a component mentioned by L. K. Koegel et al. (2016) in their outline of PRT, because it is one way of increasing responding, ergo “motivation”, in children.

The structure of LEGO Therapy has one child play the role of “engineer”, whose job it is to describe the visual instructions which come with LEGO sets to the other child, the “builder”, who assembles the construct from the engineer’s instructions (LeGoff, 2004). These “engineer” and “builder” roles situate the children as speaker and listener, so these VB skills are necessary. Analysis of data taken using the Social Interaction subscale of the Gilliam Autism Rating Scale (GARS) showed gains in measures of social competence and decreases on measures of social impairment. However, as data had been collected before research had begun, observers were not blind to treatment conditions, meaning observer bias was not controlled for. The author also highlights that the GARS has questionable psychometric validity. Further research in LeGoff and Sherman (2006) looks at the long-term outcomes of autistic children receiving LEGO Therapy when compared to a control group receiving a comparable intervention—who were receiving care at a different practice to the experimental group—over a 3-year period. Like LeGoff (2004), data was collected post-hoc from clinical files, so observer bias may account for some of the findings. Both groups showed gains in social communication skills as well as reductions in autistic social behaviours as measured by subscales of the VABS and the GARS, though gains for children in the LEGO Therapy group were greater on average.

Owens et al. (2008) compared the effects of LEGO therapy and the Social Use of Language Program (SULP) to a no-intervention control group on the Social Interaction subscale of the GARS for autistic children. A small reduction in social difficulties was observed for the LEGO therapy group, but not the SULP group or the control group. When

the groups were investigated separately on the VABS, the LEGO therapy group showed a reduction in rates of maladaptive behaviour, but the Sulp group improved in the social and communication domains, suggesting that LEGO therapy may not be as suited to social and communicative skill growth as other similar interventions.

Huskens et al. (2015) investigated LEGO therapy delivered through robots using sibling dyads where one child had a diagnosis of ASD and the other was typically developing. The robot was controlled by a trainer, who did not interact with the children directly unless a procedural rule was violated, whereby the task was corrected. The results did not demonstrate statistically significant increases in the initiation of social behaviours in the siblings with ASD. The authors note that the robot limited the range of prompts, meaning that if a prompt failed to initiate a behaviour, the prompt could not be adjusted as the robot's repertoire was pre-programmed. They conclude that the kinds of robots used in their study likely have limited utility for more complex behavioural clusters such as social skills.

Sibling dyads were also studied alongside the mother in LEGO Therapy interventions by Peckett et al. (2016), who gathered qualitative data from five mothers of autistic children. Some of the mothers discussed ways in which participating in LEGO Therapy with their children alerted them to the need to augment their verbal communication with their children, and those who were married were able to pass on communication insights to their partners. Some of the mothers also reported improvements in their child's communication, reduced "stress" levels and improved ability to "focus."

Wright et al. (2023) investigated LEGO Therapy with a large sample size ($n = 250$). Participants were split across two randomised groups, with the intervention group receiving the LEGO Therapy along with a cluster of typical support treatments for children with Autism in the northern United Kingdom, while the other group functioned as a control. The results suggest marginal gains in social and emotional skills after 20 weeks of the

intervention. The authors suggest their findings should be received cautiously due to the wide confidence intervals in their data, positing that effect sizes may be less pronounced in their findings due to the study taking place in community settings, as well as the duration of the intervention and the lower median age for their participants compared to previous research. Narzisi et al. (2021) reviewed the literature up to 2020 on LEGO therapy which gave quantitative results rather than qualitative clinical observations. Though treatment sessions implemented were variable, the findings across the papers were consistent, with gains in social skill domains and decreases in behavioural patterns such as “aloofness” and rigidity (i.e., a lack of behavioural variation) often associated with difficulties in developing social relationships. The authors also note LEGO therapy is dynamic in the range of environments it may be implemented in. However, using the John Hopkins Nursing Evidence Based Practice guidelines, the review found that 17 of the 19 studies examined were of low-quality evidence, with the other two being of good quality evidence. Only one of the studies used an RCT. Small sample sizes and the variability of social skills measures were also cited as limitations in the reviewed literature.

Lee et al. (2023) investigated parent-mediated LEGO Therapy in the home. Sessions were done remotely with a video feed connecting the participants in the home to the therapists observing. Their findings supported evidence for an increase in social communication after LEGO Therapy and validated this delivery methodology. Maintenance of treatment effects were observed up to 6-7 weeks following the intervention.

Another study looked at keeping the LEGO Therapy format, but instead looked at using other special interest stimuli selected by female autistic children, in this case a jewellery arts and crafts kit (Day & Middleton, 2024). Despite the authors noting underdiagnosis of autism in females and citing the underrepresentation of female subjects in the LEGO Therapy literature, it is not clear that the subjects of this study actually had a

diagnosis of autism at the time of research. The pre-treatment verbal behaviour skills of the subjects are also unspecified. It is not clear that the previous literature on LEGO Therapy reported that gender controlled for any of the observed treatment effects (LeGoff, 2004), though one study simply did not investigate a female cohort at all in its LEGO condition (Owens et al., 2008). The notion that the LEGO Therapy format might be adaptable to other interest subjects is one future research might investigate, since this again ties back to child-preferred materials as a means to increase motivation (L. K. Koegel et al., 2016), and some autistic children may not find LEGO motivating. The economics of the toys themselves for lower income households may also be impractical, as sets of LEGO tend to be expensive.

Many of the LEGO studies focused on “higher-functioning” autistic children, i.e. those with IQ scores at least bordering on average (Huskens et al., 2015; Lee et al., 2023; LeGoff & Sherman, 2006; Owens et al., 2008), or children who were described as having no serious impairments preventing participation (Wright et al., 2023). It is worth noting that higher scores on the VABS and higher IQ scores pre-treatment were associated with greater gains in social skills. Greater pre-test language skills also predicted greater gains from LEGO Therapy (LeGoff & Sherman, 2006).

Alternatives

The major downside to best practice for autism support is that it can be resource intensive. Parent-mediated interventions may require parents to commit time which may not be practical in their day-to-day lives, while other treatments may simply present a financial barrier, compounded by the fact that in NZ, ABA services operate out of the private sector, as they are not funded by the Ministry of Health or the Ministry of Education. Referral to a private sector contract may take place, but generally only for high risk behaviours such as self-injury (Plessas et al., 2019). Treatment plans such as EIBIs are also human resource intensive, requiring adequately trained personnel over extended periods of time. It would

seem then that an accessible, supplementary option for treatment would have utility for families and caregivers.

The SENSE theatre programme creates an environment whereby autistic children learn to perform a 45-minute play in the context of a theatre class lead by young actors. SENSE theatre has been associated with an increase in rates of vocal expressiveness and greater rapport in autistic children, as the programme produces opportunities to observe social information by increasing social attention (Corbett et al., 2023). Successful rapport building may also allow an adult to become a motivating operation for stimulus interaction (Leaf et al., 2012).

Shireman et al. (2016) used a modified PRT intervention to increase rapport between adults with ASD (and no intellectual disability) and autistic children in a play context, by keeping the intervention less structured, fading demands, having adults engage in highly preferred activities with the children, varying reinforcement, and delivering reinforcement contingent upon child mands. Movement may also help children develop motor skills (Robins et al., 2007), which following the model trains as they move around their tracks may facilitate. Many of the studies investigating the effects of ASD interventions in community settings take place through preschool or daycare (Vivanti et al., 2014), so this programme provides an alternative intervention environment when access to school is not available.

A railway modeller's club in Aotearoa/New Zealand has established a model train programme which is open to the public. It has been claimed through anecdotal testimony that autistic children who attend the model train programme, begin to exhibit improved and more frequent vocal behaviour than before attending the programme. One of the potential mechanisms driving the reported increase in verbal behaviour may be that the programme creates a social environment where the children can interact with knowledgeable adults with an expertise in the activity. While several studies note trains as being particularly appealing to

autistic children (Alhaddad et al., 2018; Baron-Cohen, 2002; Hashmi, 2023; Sasson & Touchstone, 2013) there is little extant research on trains specifically as a preferred stimuli for this cohort.

Possible explanations for the observed preference can be reasoned from what does exist. Thorup et al. (2017) demonstrated trains to be effective distractor stimuli when investigating gaze following in autistic children. Investigating play preferences in children in a clinical setting, the data in Dominguez et al. (2006) indicated that Thomas the Tank Engine toys were the most frequently interacted with toy amongst a cohort of autistic children, but were not the most preferred in the typically developing comparison group. Toy trains, and model trains are predictable (follow a fixed path, only move forwards or backwards) and controllable, while real trains also run on time schedules (Javed et al., 2015).

For an intervention to facilitate the development of social and verbal behaviours, an individual needs frequent access to contingencies which promote the fundamental behaviours through which these skills are developed. Interactions with the model trains at the exhibition may facilitate behavioural cusps due to the associated social skills and motor behaviours their operation would require. Coordinated social behaviours such as JA will be important to observe also, along with the sharing of objects between children, a specific behaviour which would require both motor coordination skills as well as JA. Parallel play is exploratory play with an object alongside another child (JA is not required for parallel play), the kind of VB skill which might be observed at the exhibition (Sundberg, 2008).

The Purpose of This Study

The purpose of this study was to ask from an ABA perspective: what evidence is there that the model train programme has benefits? What happens during sessions at the club rooms that could be beneficial? What are potential indicators of programme benefits for children, their caregivers, and the community? What are the observed and perceived effects of

attending train sessions in the community on a child with a developmental disability (such as ASD) and their family/caregiver? This mixed methods investigation aims to describe the following:

1. How children interact with the environment in ways which may facilitate the development of crucial social and language skills in autistic children.
2. What perceived benefits are reported by parents/caregivers and volunteers.
3. How the design of the environment facilitates interaction.
4. Potential indicators of benefits to autistic children, their families, and their community.

Method

Participants

The participants for this study were attendees of a model railway exhibition held in a small town in Aotearoa/New Zealand. Three groups of participants were recruited:

Group 1

Participants were children and their parents/caregivers who visited the exhibition. Children were observed to be primarily pre-school to primary school age and tended to be accompanied by one or more parents/caregivers. Twenty parents/caregivers (one from any perceived family unit) from this group also agreed to participate in an interview. No demographic or identifying data was collected. Some of these participants also participated in Group 2.

Group 2

Group 2 was a subgroup of the twenty Group 1 participants who were interviewed. They consisted of two children and two parents/guardians for the observation stage. Two additional participants were interviewed, bringing the participant total to four

parents/guardians and two children. All of the children in Group 2 were either diagnosed with or waiting on a diagnosis of ASD. Ages of the children in the observation phase ranged from pre-school to high school age, both were less than 15 years old. The two children have been given the pseudonyms “Sean” and “Alan”. Recruitment for Group 2 participants required them to identify at least one of their children as neurodivergent (a term used to refer to individuals whose neurological functions perform differently to a typically developing population, a broad term which includes autistic people), and to agree to participate in this phase of the research during the interview as part of Group 1. Participants were then given participant information sheets (see appendix A) and consent forms for themselves and assent forms for their children (see appendices B and C). Signed consent and assent forms needed to be returned with their signatures before participation in Group 2.

Group 3

This group consisted of five of the model railway club’s members. These participants were all male and responses from the focus group suggested they were of retirement age. Participant information sheets and consent forms were emailed to a senior member of the railway modeller’s club, which was then distributed at club meetings (see: appendices D and E). Members who expressed their interest in participating were then required to complete the consent forms and return them in order to be recruited.

Settings

A permanent model railway exhibition is set up at a community hall in a town in Aotearoa/New Zealand. The model railway club holds exhibition days which are open to the public primarily on Sundays, but occasionally on Fridays or Saturdays if these fell on public holidays. On alternating Sundays as well as public holidays, a diesel engine ride-on miniature train runs outside on the grounds of the domain. The exhibition has three functioning model railways (two of which may have two trains operating at any one time) which can be operated

from a control panel, allowing the train to be moved forwards and in reverse. The control panels are a series of buttons and a diagram with LED lights representing sections of the tracks, which allow the train's route along the tracks to be changed, thereby altering the trajectory of the trains. The panel also has dials through which the speed of the train can be modified. For younger children, there is a small table—which stands at waist height for toddlers—with Thomas the Tank Engine artwork on its surface, on which various toy trains are placed. Also included in the exhibition are various other models which are not interactive, such as an incomplete, non-operational model railway and a diorama of a scene from a picture book. Occasionally, model collieries with functional equipment which are not operable by the public are part of the exhibition too. For observations, we designated three “environments” within the exhibition:

Environment A

This was specific segments of the largest model railway, which stood to the right of the door approximately 1 metre into the clubroom as people walked in. Initially, the intention was to observe the entire exhibition at Environment A, however the impracticality of observing multiple people at once all moving around the exhibition, some of whom would be facing away from the researchers, meant that the researchers had trouble producing reliable data. The decision was then made to observe only some sections of the exhibition in Environment A, to increase the likelihood of the researchers observing the same participants. These sections were: the short side parallel to the door on the right of participants as they walked in, the longest part of the model which would remain on the participant's right if they were to continue straight ahead from the door to the wall at the opposite end of the clubroom, and the control panel on the opposite side of this longest side. These were chosen as participants along these areas would be oriented towards the observers. This model railway was one of the fully operable ones and had several control panels. A chair was placed in front

of this panel which children could sit on while operating the model railway. Club members were also present in this environment for groups 1 and 2, and interactions between them and the children were observed. At least one member of the model railway club tended to stand in the centre of this model and operate the model trains.

For Group 2 observations, the entire model was used as the environment, as observation of only a single participant meant adjusting the vantage of observation if the participant moved around the model was simple.

Environment B

A smaller, approximately square-shaped model railway was located on the right side of the clubroom past Environment A. This model railway likewise had a functioning model train, but only a single control panel. One member of the model railway club sits on a chair by the control panel, with one exception where this member was absent and no other member took over this role. The more discrete layout made it less necessary to conduct observations from a fixed vantage point, so observation positioning was more variable in this environment, and observers could stand either to the left or to the right of the environment.

Environment C

This consisted of a small roughly rectangular table, low enough to the ground to be approximately waist height to a toddler. The table had artwork depicting characters and settings from the children's television show Thomas the Tank Engine™. Toy locomotives and other vehicles are available on the table.

Group 3 Focus Group

The focus group was conducted in the clubroom's kitchen, at a time when the club was not open to the public. Participants sat around a rectangular table, with the two researchers sat side-by-side on one side.

Group 1 Interviews

These took place inside the community hall where the exhibition was being held. Participants were approached and interviewed in the part of the community hall where the exhibition was taking place.

Group 2 Interviews

Two of the interviews for Group 2 were conducted online via webcam. The remaining interview was conducted at the community hall which held the exhibition on one of the exhibition days. This took place in the community hall's kitchen, which was separated from the main part of the hall where the exhibition was held.

Materials

Participant Recruitment

For Group 1 passive consent was used in recruitment. This was done by creating a poster outlining what the research was, introducing the researchers, and explaining what participants could do if they wished to opt out (see: appendix F). This poster was created digitally and uploaded to the model railway club's Facebook group, as well as displayed at the exhibition itself, where it would be visible to those who attended the exhibition days. There was also a withholding consent form for those who may wish not to be observed as part of the research and want to opt out (see: appendix G).

Ethical Considerations

In order to account for participants who may have experienced negative emotional responses due to participation in this research, a pamphlet containing directions to resources for families living with autistic children was designed and kept on hand during observations and interviews (see: appendix H).

Data collection

For observational data, we developed two data collection sheets for groups 1 and 2. Group 1's observational data sheet consisted of six 20x3 grids, grouped in three sets of two, one for each behaviour across our three observation environments. Group 2's observation sheets consisted of five 20x3 grids, one for each behaviour, with no distinction made for environment. Each grid had one merged column to the left to indicate which behaviour it corresponded to (see appendices I and J).

The interviews for Groups 1 and 2, as well as the focus group discussion prompts for Group 3 were read off of sheets containing the questions/prompts, with space provided to record notes (see: appendices K, L & M).

For the document review, we obtained two application forms made by the railway modellers club for funding for two projects. These were obtained through email correspondence with the club's chairman.

For procedural integrity, a smart phone with a digital timer application installed was used, along with one pair of wireless headphones to time the observation intervals. Pen and paper refill pads were used for notetaking during the focus group, as well as for notetaking during observations.

An Apple Macbook Air with Garageband installed was also used during Group 3 to record audio.

Measures

Group 1 Observations

Partial Interval Recording (PIR) was used for observation of Group 1. Intervals lasted 10 seconds and were alternated with 10 second intervals where no observation occurred.

For group 1, we found that we could only record data reliably for the following two behaviours:

Social Interaction

Defined as: a child orienting toward another child, an adult, or a volunteer, while using words and/or gestures. Also defined as such if an adult or volunteer was oriented towards a child, while using words and/or gestures. This definition was intended to capture social interactions which could either be child-initiated or adult/volunteer-initiated. Item exchange was also included in this definition. A descriptive key for the nature of an interaction was also devised (See appendix N):

- C>V = Child-initiated interaction with a volunteer.
- C<V = Volunteer-initiated interaction with a child.
- C>A = Child-initiated interaction with an adult.
- C<A = Adult-initiated interaction with a child.
- C = child-to-child interaction.

Interaction with Trains

A child touches or manipulates a control panel, a model train, or a toy train.

Group 1 Interviews

For group 1 we designed an open-ended interview with conversation starters to collect qualitative data about how participants perceived the model railway programme and why they attended. Interviews consisted of seven questions: three were related to participant's impressions about the exhibitions:

- Do you come here often?
- Why do you like coming here? (improvised along the lines of “why did you come here today?” in situations where the answer to the previous question was to indicate that they were on their first visit).
- What benefits do you think this facility has?

1 was a transitional question designed to give participants the option to opt out of answering the remaining two questions which would ask about more personal information.

- Are you happy to tell me a little bit about yourself?

The two demographic questions which follow:

- Do you live locally?
- Are any of your children neurodivergent? Do they have a disability?

For the final question, participants were asked (conditional on their responses to questions 4 and subsequently 6) whether they would be willing to be group 3 participants:

- Would you be willing to participate in an in-depth case study?

Group 2 Observations

MTS was used again for Group 2 observations. Intervals lasted 20 seconds and were alternated with 10 second intervals where no observation occurred.

Reliable data for a wider range of behaviours was achieved for Group 2 observations. five behaviours in total were operationalised:

Social Interaction

As defined for Group 1.

Interactions with Trains

As defined for Group 1.

Joint Attention

An adult or child pointing at part of the exhibition, the other person follows the pointing with their gaze. Also defined as the target child and one other child pointing at part of the exhibition and following with their gaze, or alternatively a non-target child points at part of the exhibition and the target child follows with their gaze. Descriptive stats for the kind of Joint Attention interaction observed were also coded for. Each code was comprised of

three parts, beginning with “JA” and then followed by the direction, either < (for other initiated) or > (for child initiated) and then as follows:

- P = Parent/caregiver.
- A = An adult who is not a parent/caregiver to the target child.
- C = Another non-target child.
- V = Volunteer.

An example of this coding would be “JA>P” which describes Joint Attention initiated by the target child towards a parent/caregiver.

Parallel Play

Reserved only for observations at Environment C—the manipulation of a toy at the same time as another child at the same table.

Sharing

Physically handing over a toy or accepting a toy from someone else. A coding system for descriptive information about each occurrence was devised.

- C>SA = Child shares with adult.
- C<SA = Adult shares with child.
- C>SP = Child shares with peer.
- C<SP = Peer shares with child.

Group 2 Interviews

Group 2 interviews were conducted from a schedule containing the following questions (see: appendix L):

- How many children do you have and what are their ages?
- Would you say your child is neurodivergent?
- If so why is that?
- Do they have or are waiting on a diagnosis?

- By whom and when were they diagnosed?
- Do they receive any additional help/intervention/attend a different school?
- What is your child's biggest need/your greatest concern?

Group 3 Focus Group

Discussion Prompt

For the group 3 focus group, a schedule was devised and printed out to prompt the focus group director:

- How long have you been interested in model trains?
- What aspects of them pique your interest?
- Do you enjoy teaching the children how to use them?
- How do you teach them how to use the trains?
- Do any of the kids ask questions? If so, what are these questions like?
- What role do the parents play?
- What does being in this group of people make you feel?
- What are the benefits you have noticed from participating in this club?
- What benefits have you seen for others when visiting this club?
- Have you made any close friendships or bonds due to this club?
- Is there anything else you would like to mention that we have not asked?

Attendance

Head counts were taken by the researchers every 15 minutes of all the people not members of the model railway club who were present in the exhibition space. The researcher's estimates at each interval were averaged together. The sum of all averages calculated for that observation day was then divided by the number of head counts taken on that day to give an overall estimate of the number of participants present at any given time on that day.

Design

This study was non-experimental and aimed to provide a descriptive account of the model train exhibition as an environment, and whether indicators from the literature of benefits to children with autism and their families/communities were present in this context. A mix of qualitative and quantitative data collection methods were utilised.

Procedure

Data collection sessions usually lasted roughly two hours and began at varying times between 9:30am – 12:00am on Sundays, and between 4:00pm – 8:00pm on the Fridays and Saturdays.

Ethical Approval and Consent

Ethics approval was granted by the University of Waikato's Human Research Ethics Committee (HREC(Health)2024#12). We obtained passive consent for participants in group 1 (see Appendix F). Informed consent was obtained from parents in group 2 and assent from children (Appendices B and C). Informed consent was granted by participants in group 3 (see Appendix E).

Group 1 Observation

The structure of observations was mixed. Primarily, observation would occur at one environment for 20 intervals, and then observation was rotated to a different environment for a further 20 intervals, and this process was continued until 60 intervals had been completed for each environment. Occasionally this process was varied by remaining at an environment for the entire set of 60 intervals before rotating to another environment. Researchers would observe the environments from a fixed position. While there was no set distance researchers were to stand from each environment, they had to be at a sufficient distance where they would not interfere with activity at the environment they were observing.

Group 1 Interviews

Adult participants who were not members of the model railway club were approached during the exhibitions. Researchers first introduced themselves and indicated that they were conducting research on the model train exhibition, and asked if they would like to participate in a brief interview about their experiences. The interview was then conducted on the spot, and those who volunteered participation in group 2 were given a participant information sheet (see: appendix A) and assent and consent forms (appendices B and C). Responses to the questions on the interview schedule were taken as notes and recorded in the provided space on the sheet.

Group 2 Observation

Data was collected on days when the model railway club held their open day exhibitions which the participants attended. It had been confirmed beforehand via email that the participants would be attending on the date where observation took place. Parents/caregivers and children were directed to behave in the environment as if observation was not occurring. Researchers observed from a sufficient distance to not interfere with the children and their parents/caregivers as they interacted with the layouts. Observation did not take place from one single vantage point, instead the researchers constantly adjusted their positions as needed to have a clear line of sight on the child.

Group 2 Interviews

Interview times were organised with participants separately. Two of these were conducted via the internet using Zoom, while one was conducted in person at the exhibition during opening hours, using the same room as was used for the Group 2 focus group. The interview then followed the interview schedule previously outlined, and notes were taken for responses and recorded on the interview schedule in the provided space.

Group 3 Focus Group

A focus group was conducted with members of the model railway club. Participants were recruited by contacting the model railway club chairman and having them pass on information about the focus group to the club members. Five members responded and were provided with participant information sheets (see: appendix D) and consent forms (see: appendix E). The focus group was conducted on a day when the exhibition was not open to the public, and the club's chairman was absent for the duration. Participant's names were changed to pseudonyms during transcription to maintain anonymity. The first researcher initiated the focus group by reading from a prepared preamble to explain to participants how the focus group would proceed (see: appendix M). They then read from the group 2 discussion prompt, while occasionally ad lib prompts were interjected where relevant. The second researcher handled moderation duties to mitigate multiple parties speaking at once and to allow participants to respond while maintaining time efficiency to ask all scheduled discussion prompts.

Attendance

Estimates of attendance were measured by pausing observations every 15 minutes so that the researchers could take a count of how many people (who were not members of the model railway club) were present in the exhibition room and take down a written record of the findings. (researchers were alerted by a series of alarms set at 15 minute intervals, on the same smart phone which ran the interval timer)

Data Analysis

Group 1 Observations

Interactions with Trains

The total number of interactions for each observation day were tallied and then also converted to percentages by dividing these totals by the total number of intervals for that period and then multiplying this sum by 100.

Social Interaction

Totals and total proportion of intervals for the five types of social interaction were calculated by calculating the sum total of all intervals where the behaviours were present and dividing these sums by the total number of all observations for that environment. This was repeated for all five days. These numbers were then converted to percentages by dividing these sums by the total number of intervals for that dataset and multiplying this sum by 100. Sum totals for each kind of *Social Interaction* were then added up for each day, and proportions were calculated again by dividing these numbers by the total number of intervals for that dataset and multiplying the sums by 100.

Group 1 Interviews

Recorded responses for each question were typed up and combed through to identify recurrent responses and responses which shared thematic content. Responses which had binary responses (could be described as either yes or no) were simply tallied. These sums were then divided by the total number of interviewees (20) and multiplied by 100 so that they could be presented as proportions.

Group 2 Observation

Joint Attention

Totals and total proportion of intervals for the five types of *Joint Attention* were calculated by calculating the sum total of all intervals where the behaviours were present and dividing these sums by the total number of all observations. These numbers were then converted to percentages by dividing these sums by the total number of intervals for that dataset and multiplying this sum by 100.

Social Interaction, Interactions with Trains, Parallel Play and Sharing

The total number of recorded instances of each behaviour for each child were tallied and then also converted to percentages by dividing these totals by the total number of intervals for that period and then multiplying this sum by 100.

Group 3

The audio recording of the focus group was analysed using the guidelines suggested by Braun and Clarke (2006). This was a six-phase process for qualitative data analysis. Phase one involved transcribing the data and reading through it to become familiar with it. Phase two then involved coding the transcript, by highlighting passages of interest. These were then further organised into candidate themes and sub-themes at phase three and were refined further in phase four, where themes which were not supported by the data were discarded and the remaining themes were internally coherent and distinct from each other. These themes were then given definitions and named in phase five. Phase six then involved writing a thematic analysis of the data.

Attendance

Head counts of Group 1 (and Group 2 where applicable) participants were conducted at 15-minute intervals, and an average attendance for the exhibition was extrapolated from this by calculating the average of these head counts.

Document Review

The funding applications were read through to identify any references to autistic children/neurodivergent children or children with intellectual disabilities.

Inter-Observer Agreement

Exact Agreement IOA was calculated to establish reliability in the measures. This was calculated by dividing the number of intervals where observers reported identical data, dividing this number by the total number of intervals, and then multiplying this sum by 100.

Table 1*Inter-Observer Agreement for Group 1 Observations*

	Interactions with Trains (%)	Social Interaction (%)
Environment A	94	82
Environment B	98	84
Environment C	97	91

For Group 1 observations, both measures scored above 80% across all three environments. *Interactions with Trains* scored 94% for Environment A, 98% for Environment B, and 97% for Environment C. *Social Interaction* scored 82% for Environment A, 84% for Environment B, and 91% for Environment C.

Table 2*Inter-Observer Agreement for Group 2 Observations*

	Joint Attention (%)	Social Interaction (%)	Interactions with Trains (%)	Parallel Play (%)	Sharing (%)
Sean	91.66	86.66	86.66	91.66	100
Alan	90	91.66	91.66	100	100

For Group 2 observations, IOA for Sean was 91.66% for *Joint Attention*, 86.66% for *Social Interaction*, 86.66% for *Interactions with Trains*, 91.66% for *Parallel Play*, and 100% for *Sharing*. IOA for Alan was 90% for *Joint Attention*, 91.66% for *Social Interaction*, 91.66% for *Interactions with Trains*, 100% for *Parallel Play*, and 100% for *Sharing*.

IOA for the statistics describing which kind of *Joint Attention* occurred was 92.5%, while IOA for the statistics describing which kind of *Social Interaction* occurred was 77.5%. Because this latter measure is lower than would be expected to argue reliability, these statistics have not been included in the results for Group 2.

Results

This results section will be structured as follows: The document review will be covered at the beginning, followed by the Inter-Observer Agreement (IOA) for the quantitative data of Groups 1 and 2. This will precede the quantitative data for Groups 1 and 2, followed by the analysis of qualitative interview data from these two groups. Concluding this section will be the results of the focus group data for Group 3.

Document Review

We were provided two documents by the model railway club which detailed applications for funding. One of the documents requests partial funding for a therapeutic model railway set which can be transported to hospital wards. Their application specifies that the goal of the project is for “use with intellectually disabled children.”

The second document is also an application for funding. This application details the club’s intentions to establish research on their exhibition’s potential benefits for “neurodiverse [sic] children,” meaning neurodivergent.

Attendance

Table 3

Average Attendance of a Model Train Exhibition

	Day 1	Day 2	Day 3	Day 4	Day 5	Total
Mean Attendance	14.4	2.7	12	13	22.3	12.9

Average attendance was 12.9 over an observation session but fluctuated as low as 2.7 on Day 2 and as high as 22.3 on Day 5.

Group 1 and 2 Observations

Table 4

Total Number of PIR Intervals Completed Per Environment as Well as Indication of Ride-On Train Operation Across All Observation Days

	Intervals for Environment A	Intervals for Environment B	Intervals for Environment C	Ride-On Train Operating
Day 1	60	34	60	Yes
Day 2	60	0	0	No
Day 3	60	60	60	Yes
Day 4	60	0	60	Yes
Day 5	60	60	60	Yes

Group 1 Observations

Interactions with Trains

Table 4 shows the frequency and percentage of intervals where *Interactions with Trains* occurred. On day 1, Environment B was only observed for 34 intervals, due to a lack of activity. On Day 2, Environments B and C were not observed, due to insufficient activity. Environment B was not observed on Day 4 due to the absence of the volunteer usually present to facilitate the operation of the model train.

Table 5

Frequency and Proportion of Interactions with Trains Across Environments

	Environment A		Environment B		Environment C		Total	
	No.	%	No.	%	No.	%	No.	%
Day 1	23	38.3	11	32.4	45	75	79	51.3
Day 2	48	80	0	0	0	0	48	80
Day 3	0	0	55	91.7	19	31.7	74	41.1
Day 4	26	43.3	0	0	55	91.7	81	67.5
Day 5	15	25	32	53.3	52	86.7	99	55
Total	112	37.3	98	63.6	171	71.3	381	54.9
	<u>300</u>		<u>154</u>		<u>240</u>		<u>694</u>	
No Behaviour	188	62.7	56	36.4	69	28.8	313	45.1
	<u>300</u>		<u>154</u>		<u>240</u>		<u>694</u>	

Interactions with Trains was most frequent in Environment C. In Environment C, the trains were all toys, which children were allowed to interact with freely, thus the frequency of this behaviour in Environment C is to be expected, since the strictures imposed by the model trains (whereby touching or handling the model trains is discouraged and the trains are primarily interacted with via the control panels) are absent. Day 2 saw *Interactions with Trains* occur exclusively in Environment A. Day 2 had the lowest overall average attendance, and due to only one environment being observed at a time, this made it less likely we would observe interactions across all environments. There were days where we did not observe any interactions for some environments: Day 2 for Environments B and C, Day 3 for Environment A, and Day 4 for Environment B.

Social Interaction

Tables 5-9 display the frequencies of five kinds of *Social Interaction* and the percentage of intervals in which they occurred across the three observation environments, with a table for each observation day. Table 7 is the aggregate of all five days of data collection. The key for the different kinds of interactions is:

- C>V = Child-initiated interaction with a volunteer.
- C<V = Volunteer-initiated interaction with a child.
- C>A = Child-initiated interaction with an adult.
- C<A = Adult-initiated interaction with a child.
- C = child-to-child interaction.

Table 6*Frequency and Proportion of Interaction Types Across Environments for Day 1*

Interaction type	Environment A		Environment B		Environment C		Total	
	No.	%	No.	%	No.	%	No.	%
C<V	13	21.7	2	5.9	0	0	15	9.7
C>V	1	1.7	10	29.4	0	0	11	7.1
C<A	16	26.7	10	29.4	12	20	38	24.7
C>A	10	16.7	4	11.8	3	5	17	11
C	3	5	0	0	2	3.3	5	3.3
Total	<u>43</u>	71.7	<u>26</u>	76.5	<u>17</u>	28.3	<u>86</u>	55.8
	<u>60</u>		<u>34</u>		<u>60</u>		<u>154</u>	
No	<u>17</u>	28.3	<u>8</u>	23.5	<u>43</u>	71.7	<u>68</u>	44.2
Behaviour	<u>60</u>		<u>34</u>		<u>60</u>		<u>154</u>	

Social Interaction was most frequent in Environment A, however the behaviour occurred in a greater percentage of intervals for Environment B, although fewer observations were conducted on Environment B on Day 1. As Environment B tends to only have one volunteer and only has one control panel, it is prone to being abandoned. As is characteristic of Environment C across all observation days, no interactions with volunteers were observed at all. Adult initiated interactions with children were the most frequent interactions for Environments A and C, while child-initiated interactions with volunteers were equally frequent in Environment B. Holistically, *Social Interactions* occurred in 55.8% of all intervals.

Table 7*Frequency and Proportion of Interaction Types Across Environments for Day 2*

Interaction type	Environment A		Environment B		Environment C		Total	
	No.	%	No.	%	No.	%	No.	%
C<V	12	20	0	0	0	0	12	20
C>V	6	10	0	0	0	0	6	10
C<A	0	0	0	0	0	0	0	0
C>A	7	11.7	0	0	0	0	7	11.7
C	0	0	0	0	0	0	0	0
Total	<u>25</u>	41.7	0	0	0	0	<u>25</u>	41.7
	<u>60</u>						<u>60</u>	
No Behaviour	<u>35</u>	53.9	<u>0</u>	0	<u>0</u>	0	<u>35</u>	53.9
	<u>60</u>		<u>60</u>		<u>60</u>		<u>60</u>	

Day 2 had the lowest average attendance of all five days, and this is reflected in the comparative lack of total interactions which occurred. *Social Interactions* only occurred in Environment A, where volunteer-initiated interactions with children were the most frequent. No adult-initiated interactions with children occurred, an outlier as this type of social interaction was the most frequent overall (see Table 11).

Table 8*Frequency and Proportion of Interaction Types Across Environments for Day 3*

Interaction type	Environment A		Environment B		Environment C		Total	
	No.	%	No.	%	No.	%	No.	%
C<V	0	0	4	6.7	0	0	4	2.2
C>V	0	0	1	1.7	0	0	1	0.6
C<A	6	10	15	25	5	8.3	26	14.4
C>A	2	3.3	7	11.7	5	8.3	14	7.8
C	0	0	0	0	0	0	0	0
Total	<u>8</u>	13.3	<u>27</u>	45	<u>10</u>	16.7	<u>45</u>	25
	<u>60</u>		<u>60</u>		<u>60</u>		<u>180</u>	
No Behaviour	<u>52</u>	86.7	<u>33</u>	55	<u>50</u>	83.3	<u>135</u>	75
	<u>60</u>		<u>60</u>		<u>60</u>		<u>180</u>	

Day 3 had the lowest total occurrence of *Social Interactions* of the five days at 25% occurrence in all intervals. Adult-initiated interactions with children were the most frequent

for Environments A and B, while child-initiated interactions with adults were equally as frequent for Environment C. Environment B was the only environment where *Social Interactions* between children and volunteers were observed. No child-to-child *Social Interactions* were observed.

Table 9

Frequency and Proportion of Interaction Types Across Environments for Day 4

Interaction type	Environment A		Environment B		Environment C		Total	
	No.	%	No.	%	No.	%	No.	%
C<V	9	15	0	0	0	0	9	7.5
C>V	2	3.3	0	0	0	0	2	1.7
C<A	20	33.3	0	0	24	40	44	36.7
C>A	14	23.3	0	0	6	10	20	16.7
C	2	3.3	0	0	3	5	5	4.2
Total	47	78.3	0	0	33	55	80	66.7
	<u>60</u>				<u>60</u>		<u>120</u>	
No Behaviour	13	21.7	0	0	27	45	40	33.3
	<u>60</u>				<u>60</u>		<u>120</u>	

Day 4 had the highest percentage of *Social Interaction* occurrence of the five days at 66.7%. *Social Interactions* were most frequent at Environment A. The volunteer who would ordinarily be present in Environment B was not present on Day 4 and the model railway's location had shifted from the back of the room to be flush with the side of Environment A furthest from the door, so data was not collected for this Environment. Adult-initiated interactions with children occurred the most frequently.

Table 10*Frequency and Proportion of Interaction Types Across Environments for Day 5*

Interaction type	Environment A		Environment B		Environment C		Total	
	No.	%	No.	%	No.	%	No.	%
C<V	5	8.3	7	11.7	0	0	12	6.7
C>V	0	0	1	1.7	0	0	1	0.6
C<A	26	43.3	12	20	11	18.3	49	27.2
C>A	11	18.3	3	5	4	6.7	18	10
C	8	13.3	1	1.7	9	15	18	10
Total	<u>50</u>	83.3	<u>24</u>	40	<u>24</u>	40	<u>98</u>	54.4
	<u>60</u>		<u>60</u>		<u>60</u>		<u>180</u>	
No	<u>10</u>	16.7	<u>36</u>	60	<u>36</u>	60	<u>82</u>	45.6
Behaviour	<u>60</u>		<u>60</u>		<u>60</u>		<u>180</u>	

Average attendance for Day 5 was the highest of the 5 days. *Social Interactions* occurred in 54.4% of all total intervals, and occurred in 83.3% of intervals for Environment A, which represents Environment A's highest frequency. However, similar increasing in *Social Interactions* don't appear to be present for Environments B and C, both of which saw *Social Interactions* occur in 40% of intervals. Adult-initiated interactions with children were the most frequent kind of *Social Interaction* for all three environments.

Table 11*Frequency and Proportion of Interaction Types Across Environments for All Observations*

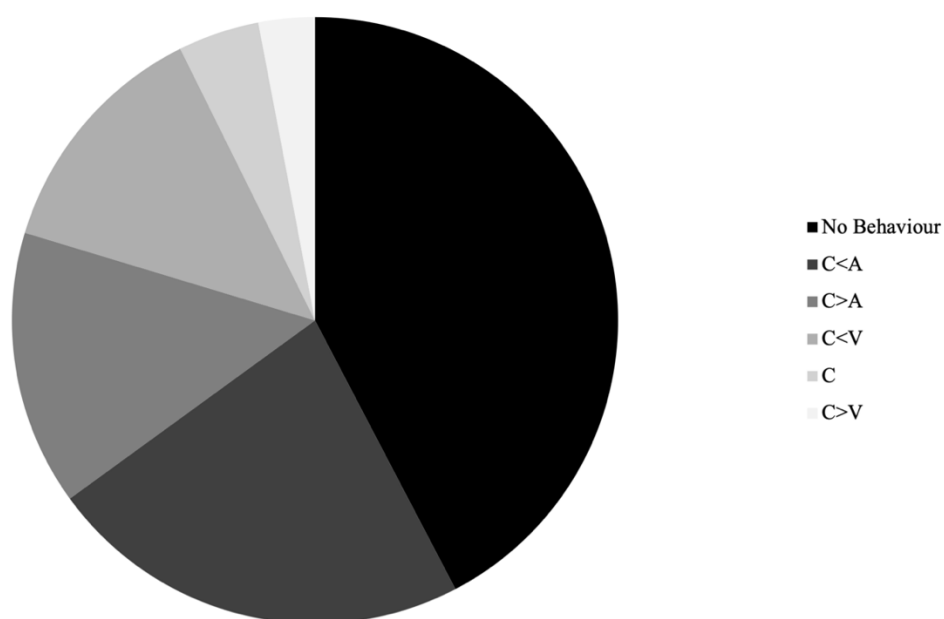
Interaction type	Environment A		Environment B		Environment C		Total	
	No.	%	No.	%	No.	%	No.	%
C<V	39	13	13	8.4	0	0	52	7.5
C>V	9	3	12	7.8	0	0	21	3
C<A	68	22.7	37	24	52	21.7	157	22.6
C>A	44	14.7	14	9.1	18	7.5	76	11
C	13	4.3	1	0.7	14	5.8	28	4
Total	<u>173</u>	57.7	<u>77</u>	50	<u>84</u>	35	<u>334</u>	48.1
	<u>300</u>		<u>154</u>		<u>240</u>		<u>694</u>	
No	<u>127</u>	42.3	<u>77</u>	50	<u>156</u>	65	<u>360</u>	51.9
Behaviour	<u>300</u>		<u>154</u>		<u>240</u>		<u>694</u>	

The aggregate results for all five days show that *Social Interactions* occurred in 48.1% of all intervals. Environment A was the only Environment where 100% of possible observations were conducted. This is likely due to its location in the exhibition, as its proximity to the entrance and relative size means it is likely to be interacted with even on days with low attendance. Across all three environments, the most frequent kind of *Social Interaction* was adult-initiated interactions with children, which occurred in 22.6% of all intervals. Interactions with volunteers were comparatively low, as well as peer-to-peer child interactions (4%), which were less frequent overall than all other types of interactions except for child-initiated interactions with volunteers (3%). When taken in comparison to the results from the five days individually, these results suggest rates of *Social Interaction* and the kinds of *Social Interactions* which occur are highly variable.

As the above results suggest that the type of interactions that occur varies with the different environments, the results from each column of Table 11 are also presented here as separate pie charts to provide a visual comparison.

Figure 1

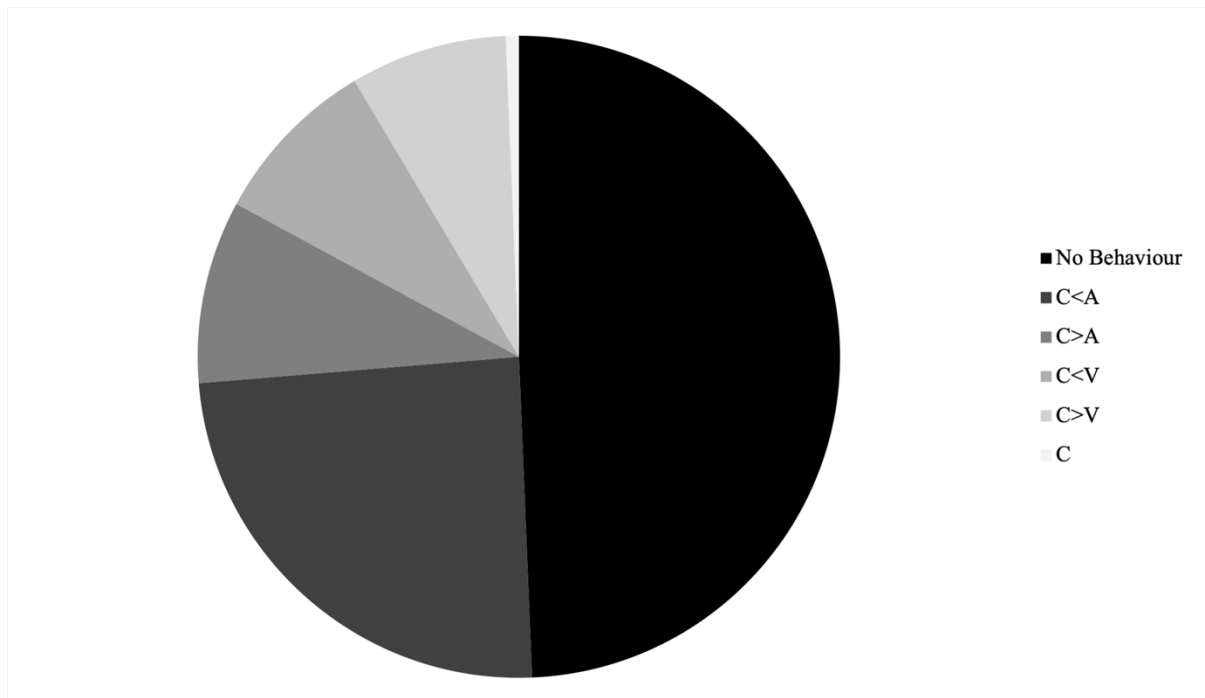
Total Proportion of Social Interaction Types for Environment A Observed Across All 5 Days



From this chart it can be seen visually that intervals with *Social Interaction* accounted for more than half of the total intervals in Environment A. Children and adults interacting represents a significant portion of the observed *Social Interactions*, while volunteers initiated interactions with children more often than children interacted with their peers or children initiated interactions with volunteers.

Figure 2

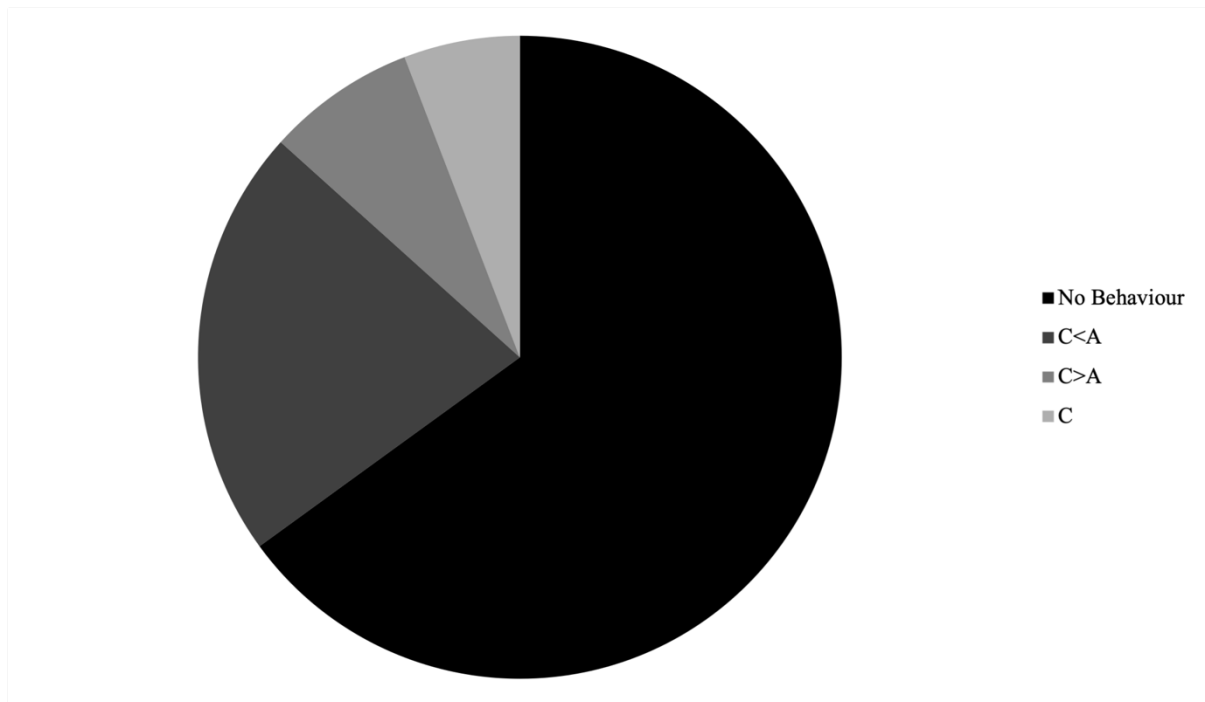
Total Proportion of Social Interaction Types for Environment B Observed Across All 5 Days



Social Interactions were observed in a slightly smaller proportion of intervals than for Environment A. Nonetheless, similar patterns emerge, with child-adult interactions again representing the greatest proportion of intervals where *Social Interactions* were observed. While volunteers still initiated more than children in child-volunteer interactions, child-initiated interactions with volunteers accounted for a larger proportion of intervals in Environment B compared with Environment A. Child interactions with peers were the least frequent *Social Interactions* for environment B.

Figure 3

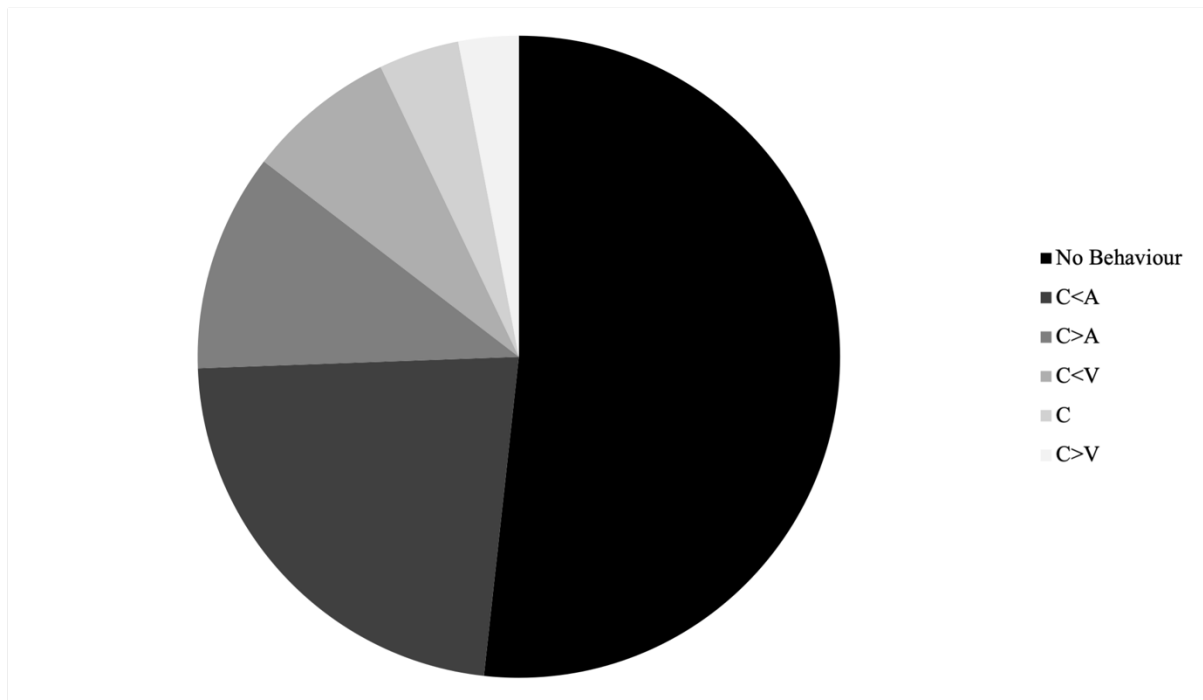
Total Proportion of Social Interaction Types for Environment C Observed Across All 5 Days



Due to the general absence of volunteers present in Environment C, *Social Interactions* occurred in a visibly smaller proportion of intervals. Even still, the pattern of child-adult interactions with adult initiations being the most frequent forms of *Social Interaction* are still seen here, with child interactions with peers being the less frequent.

Figure 4

Total Proportion of Social Interaction Types Across All Environments for All 5 Days



Overall, at least one kind of *Social Interaction* was observed to occur in 48.1% of intervals. The most frequently observed *Social Interaction* over all were adult-initiated interactions with children, followed by child-initiated interactions with adults, which can be seen here to together represent over 50% of observed *Social Interactions*, and were seen in over 25% of all intervals. Volunteers were more likely to initiate in volunteer-child interactions, with child-initiated interactions with volunteers making up the smallest proportion of observed *Social Interactions* below child-to-child interactions.

Group 2 Observations

Sean

Table 12

Frequency and Percentage of Types of Joint Attention for Sean

	Frequency	Percentage
JA>V	1	1.7
JA<V	1	1.7
JA>A	3	5
JA<A	1	1.7
JA>C	3	5
JA<C	3	5
JA>P	1	1.7
JA<P	1	1.7
Total	13	21.6

Thirteen instances of *Joint Attention* were observed (21.67%), of which one was JA>V (1.7%), one was JA<V (1.7%), three were JA>A (5%), one was JA<A (1.7%), three were JA>C (5%), three were JA<C (5%), one was JA>P (1.7%) and one was JA<P (1.7%).

Forty-four instances of *Social Interaction* were observed (73.3%), *Interactions with Trains* were observed 14 times (23.3%), *Parallel Play* was observed five times (8.3%) and no instances of *Sharing* were observed (0%).

Alan

Table 13

Frequency and Percentage of Types of Joint Attention for Alan

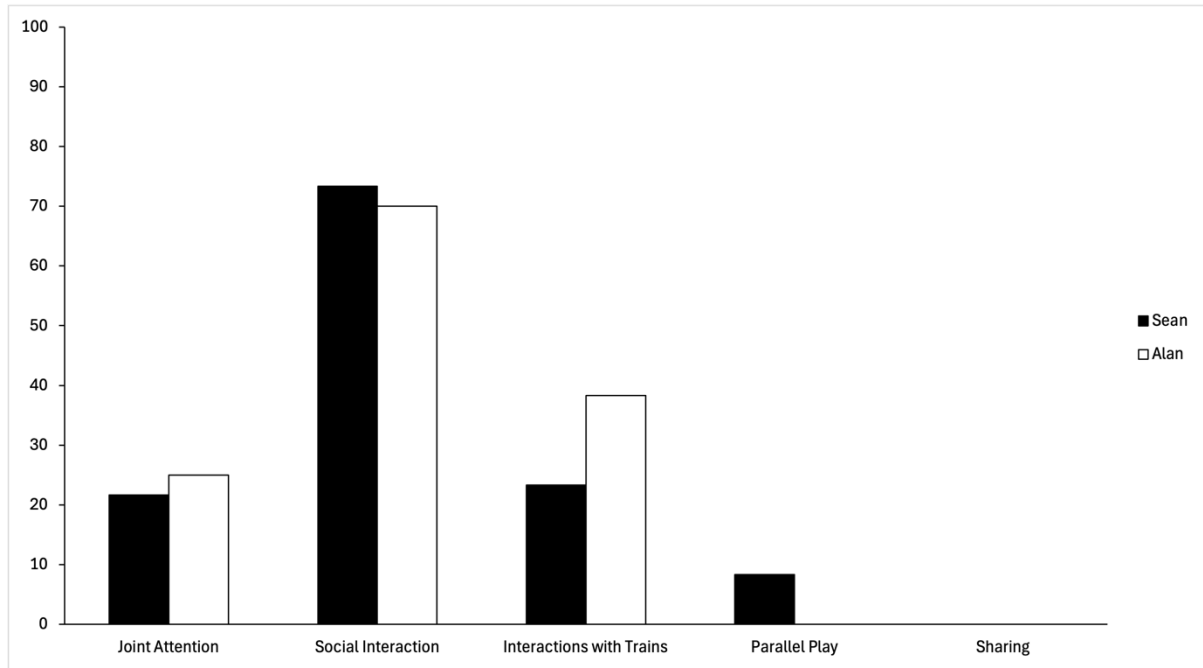
	Frequency	Percentage
JA>V	0	0
JA<V	0	0
JA>A	2	3.3
JA<A	13	21.7
JA>C	0	0
JA<C	0	0
JA>P	0	0
JA<P	0	0
Total	15	25

Fifteen instances of *Joint Attention* were observed (25%), of which no instances of JA>V (0%), no instances of JA<V (0%), no instances of JA>C (0%), and no instances of JA<C (0%) were observed. Two instances of JA>A were observed (3.3%), and 13 instances of JA<A were observed (21.7%).

Forty-two instances of *Social Interaction* were observed (70%), *Interactions with Trains* were observed 23 times (38.3%), no instances of *Parallel Play* were observed (0%) and no instances of *Sharing* were observed (0%).

Figure 5

Proportion of Intervals Where 2 Children Were Observed Exhibiting Social and Play Behaviours



Both children showed similar levels of social and play behaviours during Group 2 observation. Alan spent more time interacting with the model trains. Neither child exhibited sharing behaviours, while only Sean was seen engaging in parallel play during the observation, and this was only seen in 8.3% of intervals.

Group 1 and 2 Interviews

This section presents the qualitative data from the Group 1 and 2 interviews.

Group 1 Interviews

“Do You Come Here Often?”

Of the 20 participants interviewed, 14 (70%) gave responses which were either “yes” or indicated regular attendance of the model train exhibition, e.g., “once a week” or “once a month”. The remaining six (30%) either responded with “no” or that the date of their interview was their first time coming to the exhibition.

“Why Do You Like Coming Here?”

The most frequent response to what parent’s motivating factor for why they attend the model train exhibition was that their child enjoys trains. Fifteen of the twenty adults interviewed directly mentioned trains in their answer. Three adults mentioned their children being allowed to drive the model trains in a positive way. Three participants mentioned having positive experiences with the volunteers, suggesting perhaps that these positive experiences influenced their return visits.

“What Benefits Do You Think This Facility Has?”

- Eight participants say their kids enjoy the trains. One participant says the family enjoys trains. One participant says “good entertainment”
- Six participants imply that a benefit of the exhibition is simply that it gives children something concrete to be doing.
- Five participants say something about children learning.
- Five participants cite community aspects as a benefit of the exhibition.
- Five participants talk about social interaction/language skills for children.
- Only two participants mention familial socialisation in their comments, it seems primarily that parents bring their kids so that they can have fun and the parents can just watch them.

“Do You Live Locally?”

Nine (45%) participants answered that they were from the town where the model train exhibition was held, while 11 (55%) were from other locations.

“Is Your Child Neurodivergent?”

Seven (35%) participants responded with either “yes” or gave an answer equivalent to yes, e.g., that their child is autistic. However, it should be noted that one participant stated this child was not present at the exhibition that day. Eleven (55%) participants responded

“no”. One (5%) participant indicated that they were still waiting on a diagnosis for their child, but that they were likely autistic. One (5%) participant declined to answer.

Group 2 Interviews

“How Many Children Do You Have and What Are Their Ages?”

Only one participant reported having multiple children, the other two participants reported being single-child families. Two of the children were less than 10 years old, the remaining child was early high-school age.

“Would You Say Your Child Is Neurodivergent?”

All three participants responded “yes”

“If So, Why Is That?”

Two participants indicated that this was due to a diagnosis by a qualified professional. One participant who indicated that their child was undiagnosed, noted a family history of ASD and recognised the behavioural patterns. One of the participants whose child did have a diagnosis of ASD noted observing several hallmark behaviours and had been referred at 18 months for not yet displaying social gestures which are generally present at that age in typically developing children.

Questions on Diagnoses

This section integrates responses to three questions: “*Do They Have or Are Waiting on a Diagnosis?*”, “*If So What Is The Diagnosis?*”, and “*By Whom and When Were They Diagnosed?*”

As above, two participant’s children had received diagnoses, the remaining participant was waiting on a diagnosis. One participant stated their child was diagnosed with ASD, one participant answered that their child was diagnosed with a mix of neurological and conduct disorders. The final participant’s child did not have a diagnosis. The two participants who reported a diagnosis stated that this diagnosis had been given by paediatricians.

“Do They Receive Any Additional Help/Intervention/Attend a Different School?”

One participant said their child attends a Ministry of Education school for an hour a day, and that they also receive support from the organisation Enabling Good Lives. Another participant said that they received Child Disability Allowance and funding for homeschooling. Their child also attended an early childhood intervention and support centre when they were around 4-5 years old. The participant whose child was not diagnosed said that their child attends daycare and they are currently not receiving any additional support.

“What Is Your Child’s Biggest Need/Your Greatest Concern?”

One participant said their child required constant supervision, and they also noted violent behaviour as an emotional response as being a concern. Another participant responded that language development was their primary concern. Finding appropriate services for their child’s level of function, as well as communal education which could accommodate them were also mentioned by one participant.

Group 3

Three clusters of themes emerged from analysis of the focus group transcript. These are: themes related to older men (current or potential future members of the model railway club), themes related to the community (i.e., those who attend the model railway exhibition and their families), and mutual themes (benefitting both the community and the model railway club members). This section will outline these clusters and the themes which fall under them. All of the participant’s names and references to the model railway club and their members have been anonymised and pseudonyms are used in their place. Any other names or potentially identifying information has simply been replaced with [x].

Themes Related to Older Men

Some of the discussion focused on the volunteers and their relationship with the programme—how it impacts them. Primarily the programme is described as a positive for

them personally by the volunteers, although one theme touches on an anxiety related to the exhibition aspect of the club.

Socialisation for Older Men

The accounts by the volunteers suggest the model railway club functions as an opportunity to socialise with other men their age outside of their families. One participant elaborated on why the model railway club is a useful socialisation tool for them, describing what they feel is a general pattern of behaviour for men his age.

STEVE: You asked also why we are here, um... personally social interaction. Um... I'm retired, as a lot of retirees do you tend to wind up sitting at home driving the computer or watching the television or reading and which can become a bit concerning, you can become extremely isolated...

Engagement with a Hobby

Each of the participants described enjoying the process of modelling, and it is this rather than the trains themselves which seems to be the motivation for participating in the model railway club. Three of the participants talked about the details they add to their landscapes. The process of incorporating recycled materials into the models was also mentioned by more than one volunteer.

Sharing Knowledge

Related to the modelling aspect is the sharing of knowledge between members of the model railway club. Several members indicated that this was an element to this particular club which they had not experienced previously at other clubs.

Anxieties About Public Presence Around Models

Some participants made comments suggesting there is an extent to which the open exhibition days can be aversive. They express anxieties about members of the public

damaging the models. One of the volunteers mentioned that they choose not to attend the exhibition days.

DAVID: I think we've got to be honest and say a lot of us are kind of nervous about children because they seem quite random to us---

[...]

DAVID: ---and a lot of us are anxious that they might touch things and break them or cause major accidents. So we have to learn to live with those things and some of us just don't participate in the Sundays at all.

STEVE: I'm one of those.

Within this theme is also the feeling that non-club members perceive railway modellers as adults who play with toy trains, and therefore do not take the hobby seriously and incorrectly perceive the model trains to be inexpensive toys.

STEVE: There is also a perception I believe the public has that we are essentially a bunch of old guys playing with toy trains, emphasis on the toy. In fact, what we've got, our trains are actually mechanical marvels, they're actually quite... I won't say delicate, but they are impressive bits of engineering, so of course mummy and daddy think that toy trains are toy trains and of course the children pick it up children bring it up "oh it's a toy you could buy it at the warehouse" something like that which in fact is not the case...

Themes Related to the Community

The discussion touched upon a primary theme related to children and their families who visit the exhibition, which is the opportunity for children to learn things from the exhibition and the volunteers.

Learning Opportunities

This theme is of particular relevance to the children who visit the exhibition. One member discussed using the model railways and mines as a way for children to learn about the country's history:

STEVE: ---To teach viewers at exhibitions about New Zealand history uhh to, um I guess educate in all sorts of directions. Kids learn colour cause we I operate on a Where's Wally type system and children have questions they can ask and the adults they have all sorts of questions about our maps.

Two club members discussed teaching the children how to operate the controls. Their remarks suggest that children are quick to take instruction and learn this task.

MICK: They're pretty good and they're all excited to get on the controllers and, you know, you show them how to turn the controllers, which way to stop, which way is go and um... and then say "okay try that one" and then "try this one" you know, and in about 5 minutes they're off, they've got it, they've got it off to a tee you know?

DAVID: That's something I hear very often is how quickly they learn...

MICK: Yeah, they're quick.

They also suggest that some of the children demonstrate exploratory behaviours, and attempt to figure out if the model trains can do more than just drive one part of the track:

MICK: The majority of them just drive it, but a lot of them are interested to know that it doesn't just go around "how can I get that to go across there?" You know, change it from one traffic cross to another. "Can you go up and down the station?" and stuff like that, you know, back and forward up onto the turntable, you know, so that they are looking and seeing what's actually on the layout.

Though the context of this part of the discussion was about a perceived gender difference in how children learn to drive the model trains, this club member here highlights how young some of these children who are learning to do this task are:

STEVE: ...little girls carefully [sic] driving, they'll take instruction, they'll actually develop their own ideas, there was one I saw recently as a three-year old had three trains running at once, little girl and that requires a fair degree of thought and effort...

Upon being asked what benefits the club members perceive for children who come along to the exhibitions, one member remarked that the children seem to be more talkative once they take control of the model trains. Other members corroborated this with their own observations.

MICK: ... I usually find that they won't say anything to anybody, but you get them onto the controller, and they start concentrating on the controller... then they start talking, you know? And they say a few words and that. One young lad that comes from, way down [x], they come from [x], they're members and they look after the young lad, and his name's [x] you know, that boy now will talk to everybody, but when he first came, he just sort of looked and he wouldn't do anything, you know? Until he got onto the controllers themselves, and then he started operating: one train; two trains and then I would say to them, "[x] show this little girl how to do the controller" and he would explain to them about how to do the controller and the two of them would, off they would go for half an hour...

ROB: I guess they get to learn that you don't get bitten at here, and it's a good place to be.

The model railway exhibition also seems to serve as a means through which children can discover a new hobby, as one member remarks that one autistic child had become interested in model trains through attending the exhibition and his parent was purchasing equipment for him to begin assembling his own tracks.

MICK: Well as I've said to you there's umm, two or three parents that have kids on the spectrum and that, and one of them's coming on Friday... cause we've just sold them a whole load of gear to start building and [x], [x] is the young lad he's quite high on the spectrum, we've sold them a whole lot of points and tracks and a controller to start his, and him and his dad have virtually got it half done already...

Mutual Themes

This cluster of themes are ones which both the community and the model railway club members are tied into, such as benefits which may be bi-directional.

Affordability

There are two aspects to this theme. For the club members, the membership fees are very low.

RICHARD: Oh, just the fact that it costs us \$2.00 a week to join this club and it's a bloody good \$2.00 well spent.

Members of the public who visit the exhibition are encouraged to make small donations as they walk into the clubroom. One of the volunteers explains that, in comparison to other social activities such as a trip to the cinema, the model train exhibition represents a low-cost alternative.

DAVID: On a more basic level, parents are desperate, particularly on wet weekends for things for their kids to do. They can come in here for a whole afternoon, for a gold coin. And there are not many places that'll do that for you now.

Familial Socialisation

For the community, the model railway exhibition is a social activity where parents and children get to interact in a novel environment outside of the home. Two volunteers mention some degree of spousal involvement with the modelling.

RICHARD: My wife she's a patcher, you know she does all this sewing and stuff, but I use her quite often in my railways, I ask her opinion, sort of thing, you know? I use her as a springboard as to whether I've got it right or whether I've got it wrong, because you can't always get it right you know?

Another member gave an anecdote about a man who had come to the exhibition with his family, who recognised a model on one of the displays at the exhibition as being similar, if not identical, to a model his grandfather had had.

MICK: Yeah that reminds me... the big static layout up there... on the wall, on Sunday a family came in and dad went straight to the... trains on the thing and he said... "I used to play with my granddad's exactly like that" he said "it was exactly like that" you know, and he was wrapped to see it again "well those ones are 80 years old plus" and he said that "I used to play with that when I was a kid, that was my granddad's"...

Audience Engagement

This theme describes attempts by the modellers to incorporate novel details into their models, in order to generate interest in the layouts from visitors to the exhibitions. There is a mutual benefit to both parties here, as the visitors become actively engaged with the environment, and the discovery of novelties may be motivating and they may come away with positive perceptions of the model railway club.

STEVE: Tying in with that at exhibitions, I have a dinosaur actually two dinosaurs in any layout that I'm exhibiting and that... the dinosaurs are not obvious. They might be hiding behind a truck or sitting up on a tree they could be doing anything and that serves a dual use: kids are mad keen on dinosaurs, so send them off on a dinosaur hunt...

[...]

Once they've worked out that there is something on the layout that's unusual, they'll actually go hunting and that can create some very hilarious situations at... in exhibitions especially and here as well where people, lots of people spend a lot of time trying to find item X which is there somewhere, and they also get to learn and see other aspects of the layouts which they wouldn't probably see otherwise.

On the other hand, the club members get the opportunity to talk about their modelling, which may in turn be motivating for them.

STEVE: Model railway modellers are probably the original recyclers, we've been doing it for almost 2 centuries now and I think a lot of us go and let's say for example one of us goes to the op shops go wherever our tendency tends to be "oh how can we recycle this? How can we get this on our layout?" and part of the fun in some cases it's trying to challenge people, viewers, as to what the item might have been originally before it was converted, before it was got at, and you can be very, very creative; it is remarkable what can be recycled.

Discussion

Anecdotal evidence from members who volunteer at a model railway exhibition suggest an increase in verbal behaviour skills in autistic children after having been shown how to operate the model trains. The aims of this research were to describe how children interact with the environment in ways which may facilitate the development of crucial social and language skills in autistic children, what perceived benefits are reported by parents/caregivers and volunteers, how the design of the environment facilitates interaction, and potential indicators of benefits to autistic children, their families, and their community. To achieve this, this study used a non-experimental, mixed-methods approach

Aim 1

The exhibition has two outlets for structured play and one for exploratory play. Structured play was observed at the model railways, Environment A and the surrounding model, and Environment B. Within these environments, children were observed to initiate social interactions with adults, volunteers, and other children, as well as receive social interaction initiations from these cohorts. Play is an important “learning to learn” skill for children. It acts as a way for children to learn new motor skills and can also open up opportunities to learn social skills, including those important for language development (Charlop et al., 2018a). Through facilitation by volunteers, children were also seen to interact with the model trains via their interactable control panels. Exploratory play was facilitated in environment C, the toy train table, where children were observed to frequently interact with the toy trains. Social interactions were also observed in Environment C, however this was less frequent than in other environments, and the type of social interaction children encountered was more limited.

Social initiation in children is an important indicator of communication skills development, so it is a crucial observation (L. K. Koegel et al., 2016). The results show that initiations for JA did occur for our Group 2 case studies, though Alan only initiated twice and only with their parent/caregiver. Sean was actually seen to initiate JA bids at comparable rates to which they received them. However, because of insufficient IOA, we cannot see how many initiations occurred in other social interactions, simply that social interaction occurred.

JA was observed in both case studies. At least one of all variations of JA interactions we looked to observe were seen with Sean, while we only observed JA with Alan with their caregiver, whom they were in close physical proximity to for the duration of the observation. There is likely a notable difference in language skills between these two children which might explain these observations, and this would be in line with what is seen in ABA-based

treatments such as the ESDM, where a prerequisite level of language skill is often an important predictor of treatment outcomes (Contaldo et al., 2020; Laister et al., 2021). Increasing bids for JA is a way researchers and practitioners expect should increase language skill development (Siller & Sigman, 2008), so its observation in the Group 2 case studies is an important to describe how the model railway exhibition could benefit autistic children. There may be potential for interventions which target JA in naturalistic settings, such as JASPER, to be utilised in settings like this (Chang, et al. 2016; Lawton & Kasari, 2012).

Rates of social interaction for children were variable across different days and environments. Social interaction tended to be more frequent in Environments A and B, where children were more likely to come into contact with the volunteers. This was evident on Day 3, where no interactions were observed between children and volunteers in Environment A and only five intervals were observed to contain child-volunteer interactions in Environment B, producing a lower overall percentage of intervals where interactions were observed for Day 3 compared to all other days. Day 3 did not see any children interact with the trains at Environment A, which is likely an important mediating factor for child-volunteer interactions, since Environment B did see interactions with trains. On Day 4, there was no volunteer present at Environment B to facilitate interactions with the trains, thus also eliminating potential for child-volunteer interactions. These two observations suggest the presence of the volunteers are a significant factor in facilitating social interaction for the children, whether directly through the operation of the trains, or indirectly by other means. Day 2, which had the lowest average attendance overall, saw no observed interactions at Environments B and C.

Environment C tended to have less child-initiated interactions with parents/caregivers, though the overall number for adult-initiated interactions with children is quite similar to Environment A. While Environment C did show the highest overall rates of peer-to-peer

interactions between children, peer-to-peer interactions in general were lower overall compared to other forms of social interaction, higher only than child-initiated interactions with the volunteers. For Environment C, this might not be unexpected, as the children who played at Environment C tended to be toddlers.

The way parents/caregivers interacted with their children may also have had an effect on the kinds of behaviours observed. For example, smaller children may have been held up by a parent/caregiver while they walked around the exhibition. This not only increases the child's proximity to this adult, which potentially increases the likeliness of a child-adult interaction being observed, but it also stops the child from roaming, potentially decreasing the likeliness of a peer-to-peer interaction or an interaction with a volunteer, as well as potentially decreasing the opportunity to interact with the trains. Conversely, this was not the case for Environment C, where the children were allowed to interact with the table and the trains unimpeded.

The effect of attendance on engagement with the environments at the exhibition is not clear without experimental data. The results do not tell us what happens at the individual level, as it may be the case that individual children interact with the trains, adults, volunteers, and peers at the same rate regardless of how busy the exhibition is. For example, the insufficient activity at Environment B on day 1 for observation does not seem related to the mean attendance, since the mean attendance on Day 1 (14.4) was higher than for Day 3 (12) which had sufficient activity at Environment B that it could be observed for all 60 intervals.

One behaviour we did not observe at all during the Group 2 case studies was *Sharing*. With there only being two case studies to draw from, it is difficult to draw any conclusions from this, though a few things can be said about this. Considering this behaviour requires object coordination between two or more children, the likeliest environment this would occur at is Environment C, which restricts the frequency it would likely occur as the Group 2

participants were observed wandering between all three environments. While we were not able to observe *Sharing* for Group 1 due to insufficient IOA, we observed *Interactions with Trains* on four out of five days at Environment C. Environment C's toys would be the simplest objects for children to share, and given *Interactions with Trains* was observed as frequently as 91.7% of intervals for Day 4, this would have been useful data to compare.

Aim 2

20 participants were interviewed for Group 1. From this cohort, the model railway exhibition appears to draw regular attendance, with 70% of participants responding that they came often. Trains were mentioned directly in 75% of answers to the question "why do you like coming here?" Within these responses, there were three participants who mentioned that the children being able to control the trains was a positive aspect of the exhibition. Positive experiences with the volunteers were also mentioned in participant's responses. Of the 20 people who participated in the Group 1 interview, 35% indicated that their child was neurodivergent or autistic, with one (5% of participants) participant still waiting on a diagnosis for their child. As a sample, this number is well above the population distribution of ASD in Aotearoa/New Zealand, which is only 1% (Thabrew & Eggleston, 2018). 40% of participants stated their child enjoyed the trains and 15% specifically mentioned that the children being allowed to operate the model trains was a factor that kept them returning to the exhibition.

When asked directly what benefits they felt the exhibition had, Group 1 participants gave a variety of answers. 25% of participants felt that their children got to learn something. Interestingly, familial socialisation does not seem to be a primary motivating factor for parents, with only two (10%) Group 1 participants mentioning spending time together as a family. Instead, parents felt the model railway exhibition was a useful way to get the children to do something "concrete" (i.e., off of their digital devices) and allowed the parents the

opportunity to supervise from a distance while the children engaged with the exhibition on their own. However, five participants (25%) felt that there was a community aspect to the exhibition which was beneficial. Slightly less than half of participants lived locally to the exhibition. Opportunities for social interaction/language skills was also a benefit mentioned by Group 1 participants.

Aim 3

The exhibition is open to the public on Sundays, and occasionally on public holidays. During observation, the exhibition saw on average 12.9 members of the public in attendance at any given time; when sampled at 15-minute intervals, mean attendance ranged from 2.7 to 22.3. The document review suggests that there is an active effort by the model railway club to provide a service for children such as those who are autistic, with two applications for funding related to children who require additional support. It is important to note that the exhibition is only open to the public one day a week. Coupled with the fact 70% of Group 1 participants said that they came often (and that on an individual level, this sometimes meant once a month or less), rate of delivery for the exhibition as an intervention is lower than what is considered optimal in the literature (Drew et al., 2002; Oono et al., 2013; Vismara & Rogers, 2010).

The exhibition's attendance seems to vary depending on external activities, namely whether or not a miniature-scale ride-on train was operating at the community centre grounds. Days where the ride-on train attraction was operating tended to draw higher attendance figures than those on which it was not. The model railway exhibition has reached an audience outside of the local community, with several Group 1 interview participants responding that they did not live locally. Given that an interest in trains was frequently cited as a draw for Group 1 participants (75% of responses to "why do you like coming here?" referenced trains), perhaps the programme could expand its field also to visitors for whom

trains are not a special interest. For example, the exhibition already has other displays which are not railways, such as the picture book diorama and the collieries which are occasionally present. One of the Group 3 participants mentioned that they approach exhibiting their models as a way to teach Aotearoa/New Zealand history to children, perhaps this is an angle (at least via the use of historicity as a baseline) which could be leant on more visibly to attract more visitors.

An important theme that emerged from the Group 3 was *audience engagement*. The modellers add salient features to their model's geography, which they sometimes use to actively encourage visitors to engage with by telling them about hidden features they can find. This is one way the exhibition can also increase opportunities for social interactions for children across all three potential speaker/listener partners.

Some of the Group 1 interview participants indicated they had positive interactions with the volunteers. The importance of this for the children lies in Leaf et al. (2012), which suggests rapport building can develop adults into motivating operations for children, facilitating interaction more reliably. Environment A overall produced the highest rates of social interaction between children and volunteers. Corbett et al. (2023) described the SENSE theatre programme, which taught the performance of a 45-minute play to young actors. For the autistic children in this cohort, SENSE is associated with an increase in vocal expressiveness and rapport with novel peers. In their discussion, the authors of this paper explain that one of the reasons the SENSE programme may be so effective at increasing these social behaviours is because it represents an environment where autistic children can engage in an activity with people who are accomplished in that activity. It stands to reason that the model railway exhibition may function in a similar way.

The mechanisms for the operation of the model trains, particularly in cases where more than one child is operating trains along one model railway, are similar to those seen in

the LEGO therapy interventions. (LeGoff, 2004). LEGO Therapy situates children into speaker and listener roles both in order to co-ordinate the construction of the LEGO sets between each other, but also in taking instruction from the teacher, helping them to develop crucial VB skills. Environment A, with its multiple control panels, opens possibilities for co-ordinated operation of the trains and the tracks between children, potentially creating a similar environment whereby children must master these speaker/listener roles to co-ordinate the movement of the trains. Future research could be done to examine whether findings similar to that of Day & Middleton (2024), where alternative stimuli were used in place of LEGO to better engage the special interests of different children. This hypothesis would be in line with the child-preferred materials component used in PRT to increase child responding (L. K. Koegel et al., 2016).

Aim 4

As indicated by Tripathi et al. (2022), the parents of autistic children report higher levels of stress. This may explain why familial socialisation was only mentioned twice by Group 1 interview participants, and that generally parents tended to say they preferred simply watching their kids. Parental stress may be related in part to having to manage problem behaviours in autistic children, such as tantrums and violent behaviour (which was mentioned by one of the Group 2 participants) (Moes, 1995), and there is evidence that play can lead to a reduction in these kinds of problem behaviours (Camacho et al., 2014; McDonald et al., 2012). The model railway exhibition represents an environment where recreational activity can be facilitated by other adults or peers, potentially temporarily removing elements of parental stress. This serves a double benefit, both to the parents of autistic children and the children themselves.

As Aotearoa/New Zealand is a country which appears to underfund and underservice ABA services comparative to population need (Thabrew & Eggleston, 2018), the model

railway exhibition's affordability is an added benefit to families with autistic children. While not a replacement for best practice treatments, it has utility as an affordable alternative in the interim, particularly for individuals who may not be receiving any treatment otherwise, as was the case with at least one child in Group 2.

Limitations and Future Research

Conducting this research presented a few logistical problems. Initially, one of the variables we wanted to codify and observe was whether or not the social interactions were "positive" or "negative". However, the researchers quickly discovered that the environment, the need to make the researcher's presence as non-invasive as possible, as well as the reality of observing multiple participants at the same time made it too difficult to ascertain what was being said, and therefore determine the nature of an interaction, so this idea was quickly abandoned. There were also limited opportunities to collect data, as at best the exhibition would be open once a week, and there were some weeks where it was not open to the public for various reasons.

While the researchers were able to observe a wider variety of behaviours for the Group 2 case studies, achieving the same for Group 1 with these methods became impractical. Multiple observations were required before eventually settling on an observation schedule which produced reliable data, which required opting not to observe several behaviours (such as JA) which would have been of interest, as early observation attempts did not produce reliable data on these behaviours for Group 1. Observing multiple participants with an observation schedule containing up to five different behaviours made it less likely that the researchers would observe the same behaviour from the same participant at the same time, reducing inter-observer agreement. For future research, a stationary video camera could be considered for observation, as this would allow for multiple viewings and a consistent vantage for observation. By a similar notion, audio recording likely would have produced

richer data for the group 2 interviews also, as was done for Group 3. Group 2 interview data would also likely have benefitted from a broader range of questions, perhaps in a similar structure to the focus group for Group 3.

It is possible that the findings of this research lack generalisability. Our Group 1 cohort is a small sample (only 20 participants), and their interviews suggest that a significant portion of this cohort already enjoy trains, which raises questions about how representative this sample is of the wider populace. This is possibly a significant contributing factor for return visitors and possibly affects children's willingness to engage with the environment. While several studies point to trains as a salient interest for autistic children (Alhaddad et al., 2018; Baron-Cohen, 2002; Dominguez et al., 2006; Hashmi, 2023; Javed et al., 2015; Thorup et al., 2017), the literature on this subject is limited, and some of this evidence such as the findings in Dominguez et al. (2006) is purely circumstantial, perhaps less about the trains themselves and more to do with the Thomas the Tank Engine branding, which may be appealing to children for other reasons.

Implications and Conclusion

Best practice interventions for autistic children are not always financially feasible or resource practical for all families, however this does not mean that nothing can be done in the interim. This study investigated an exhibition put on by a railway modeller's club where children are invited to drive the operable model trains under the guidance of the club's volunteers. This research appears to be one of the first to specifically investigate the potential of a model train exhibition as a programme for supporting autistic children and their families. During observations, we found evidence that behaviours which are associated with language development in autistic children were present. This has implications for its potential utility as a resource for families of autistic children, particularly if they are not currently receiving any other treatment. Further research could look to apply experimental designs to compare pre-

and post- programme verbal and social behaviours. Future studies might also look to study similar initiatives.

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Appendix A: PARTICIPANT INFORMATION SHEET GROUP 1

Dr Angelika Anderson School of Psychology The University of Waikato Phone: 07 838 4466 ext 9209 Email: angelika@waikato.ac.nz	Tamara Geary Email: tg90@students.waikato.ac.nz
	Jacob Gedye Email: jg311@students.waikato.ac.nz

Project title: Preliminary evaluation of a model train community initiative

Dear visitors to the Greater Waikato Railway Modellers (GWRM) Sunday exhibition.

We (Jacob Gedye; Tamara Geary) are masters students at the University of Waikato, supervised by Dr Angelika Anderson, doing a research project investigating the impact of the model railway programme. This research will be used to write our masters' theses. Please read this information sheet so that you can decide whether you would like to participate or opt out.

What is this research about?

Our aim is to describe the model railway programme and explore what benefits it may have for families who visit. We are particularly interested in any benefits that the programme has for children's development, in particular children with disabilities, and neurodivergent children.

What will you have to do?

To participate, just behave as you usually would and enjoy the trains. We will be here and observe how visitors interact with the trains and other people in the room. We are particularly interested in how children learn and communicate. We will not find out your name or any other personal information though we may also ask you to participate in a brief interview if you wish to find out how often you come here, what you like about the programme, how many members of the family attend, and whether any of your children have a developmental disability / neurodivergence. Families with neurodivergent children can then opt into a more in-depth case study. We are happy to answer any questions you may have about the research.

Potential benefits

Very little is known about the potential benefits of community initiatives like this. Any evidence of benefits could help grow the project, or develop other similar ones, so more families could benefit.

Right to withdraw

It is entirely your choice to participate in this research project. You can opt out and also withdraw at any time without giving a reason.

Confidentiality

Participation in this project is confidential. You do not need to give us your name. If you do it will be kept confidential.

How to participate

To participate you do not need to do anything. Continue your visit as you ordinarily would. If you wish to opt out, please fill in the opt-out form and let us know. We will then ensure that you and your family will not be observed or be interviewed.

This research project has been approved by the Human Research Ethics Committee at the University of Waikato as HREC (Health2024#12). Any questions or concerns about the ethical conduct of this research may be sent to the Secretary of the Committee, email humanethics@waikato.ac.nz, postal address, Human Research Ethics Committee, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

CONSENT FORM

A completed copy of this form should be retained by both the student and the guardian of the participant.

Behavioural psychology masters: Impact model trains have on people

Please complete the following checklist. Tick (✓) the appropriate box for each point.	YES	NO
1. I have read the Information Sheet (or it has been read to me) and I understand it.		
2. I am willing to give consent for _____ (child's name) to participate in this research.		
3. I have been given sufficient time to consider whether or not to allow _____ (child's name) to participate.		
4. I am satisfied with the answers I have been given regarding the research and I have a copy of the information sheet and this consent form.		
5. I understand that being part of the research is voluntary (my choice) and that I may withdraw consent at any time without penalty.		
6. I understand that I have the right to decline consent for _____ (child's name) to participate in the research.		
7. I know who to contact if I have any questions about the research in general.		
8. I consent to researchers observing me and my child interacting with the model trains.		
9. I understand that the information I provide could be used in future academic publications.		
10. I wish to receive a copy of the findings.		

I agree for _____ (child's name) to participate in the research for the masters thesis, and I understand that I may withdraw my consent at any time. If I have any concerns about this project, I may contact Angelika Anderson (angelika.anderson@waikato.ac.nz) to discuss further.

Guardians name (Please print):

Signature: _____

Date: _____

Appendix C

CONSENT FORM

A completed copy of this form should be retained by the student.

Behavioural psychology masters: Impact model trains have on people

Please complete the following checklist. Tick (✓) the box you agree with.	YES	NO
1. I'm ok with these students watching while I play		
2. I can tell them to stop if I want to		

Appendix B: PARTICIPANT INFORMATION SHEET GROUP 2

Dr Angelika Anderson School of Psychology The University of Waikato Phone: 07 838 4466 ext 9209 Email: angelika@waikato.ac.nz	Tamara Geary tg90@students.waikato.ac.nz
	Jacob Gedye Email: jg311@students.waikato.ac.nz

Project title: Preliminary evaluation of a model train community initiative

Dear members of the Greater Waikato Railway Modellers (GWRM)

We are doing a research project investigating the impact of the model railway programme. We (Jacob Gedye; Tamara Geary) are two master's students at the University of Waikato, supervised by Dr Angelika Anderson. This research will be used to write our masters' theses. Please read this information sheet so that you can decide whether you would like to participate.

What is this research about?

We were invited by Paul Murphy to conduct this research project. Our aim is to describe the model railway programme and explore what benefits it may have for families who visit. We are particularly interested in any benefits that the programme has for children's development, in particular children with disabilities, and neurodivergent children.

Who will be participants?

For this part of the research project, the participants are members of the GWRM who are present at the Sunday sessions of the model train programme.

What will you have to do?

We would like to invite you to participate in a focus group, consisting of you and other members of the GWRM. We are interested to hear your experiences with, and views about the programme: what you like about it, what you have noticed about the way families interact with the trains, and in particular how children interact with the trains and other people in the room. Focus groups will be held in a room provided at the Leamington Domain, Cambridge at a time convenient to you, and without Paul Murphy being present. These focus groups will be audio recorded. During the focus groups, the researchers will ask questions to stimulate discussion. They may also ask follow-up questions related to talking points during the session. You do not have to respond to any questions if you do not want to. We expect that the focus groups will take 1 – 1 ½ hours. Paul Murphy will not have access to any recordings or transcripts. He will only have access to a summary report of the focus groups.

Potential benefits

Very little is known about the potential benefits of community initiatives like this. Any evidence of benefits could help grow the project, or develop other similar ones, so more families could benefit.

Right to withdraw

It is entirely up to you whether you wish to participate in this research project. You are free to withdraw from the research project at any time and without giving a reason. It may be difficult to withdraw your data / voice from any recordings, but we can remove your statements from any transcript if you wish. You will have the opportunity to review the transcript before we begin the analysis. You will need to respond with any comments or alterations to the transcript, or request to withdraw from the study, within 2 weeks of receiving the transcript. If you have any further questions, you are free to contact any one of the researchers at any time.

Confidentiality

Participation in this project will remain confidential. Though the researchers will likely know your name, pseudonyms will be used on any documents or reports.

This research project has been approved by the Human Research Ethics Committee at the University of Waikato as HREC (Health2024#12). Any questions or concerns about the ethical conduct of this research may be sent to the Secretary of the Committee, email humanethics@waikato.ac.nz, postal address, Human Research Ethics Committee, University of Waikato, Te Whare Wananga o Waikato, Private Bag 3105, Hamilton 3240.

Appendix E: GROUP 2 CONSENT FORM

Appendix E

Project title: Preliminary evaluation of a model train community initiative

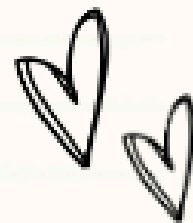
Please complete the following checklist. Tick (☐) the appropriate box for each point.	YES	NO
1. I have read the Information Sheet (or it has been read to me) and I understand it.		
2. I am willing to give consent to participate in this research		
3. I have been given sufficient time to consider whether to participate.		
4. I am satisfied with the answers I have been given regarding the research and I have a copy of the information sheet and this consent form.		
5. I understand that being part of the research is voluntary (my choice) and that I may withdraw consent at any time without penalty.		
6. I understand that I have the right to decline consent to participate in the research.		
7. I know who to contact if I have any questions about the research in general.		
8. I understand that the students will need to audio-record the focus groups.		
9. I give consent for the students to audio record some of their work with me in it. This audio will be anonymous and kept in a secure place. Paul Murphy will not have access to them.		
10. I consent to researchers observing me interacting with the model trains and other people.		
11. I understand that the information I provide could be used in future academic publications.		
12. I wish to receive a copy of the findings.		

I agree for to participate in the research for the masters' theses, and I understand that I may withdraw my consent at any time. If I have any concerns about this project, I may contact Angelika Anderson (angelika.anderson@waikato.ac.nz) to discuss further.

Name (Please print):

Signature:

Date:

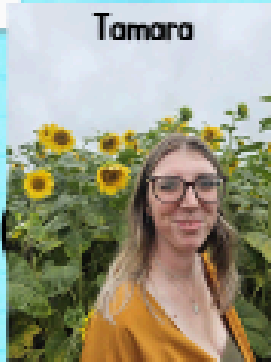


Appendix F

TRAINS

01

Tamara



Research

We are conducting some research on how visiting the GWRM might benefit people. This research involves us observing visitors to the GWRM

Dates

We will be at the GWRM clubrooms on these dates

- June 9th
- June 16th
- June 28th
- July 7th
- July 21st

02

Tamara's email

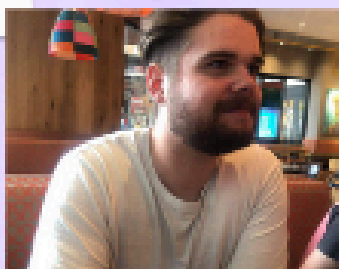
tg90@students.waikato.ac.nz

Jacobs email

jg31@students.waikato.ac.nz



03



Jacob

Researchers

This is us! Please feel free to reach out if you want to share your experience. Also, let us know if you would rather not be observed. It is entirely up to you if you want to be included in our research or not

Appendix D: WITHHOLDING CONSENT FORM PARTICIPANTS GROUP 1

Appendix G

Dr Angelika Anderson School of Psychology The University of Waikato Phone: 07 838 4466 ext 9209 Email: angelika@waikato.ac.nz	Tamara Geary Email: tg90@students.waikato.ac.nz
	Jacob Gedye Email: jg311@students.waikato.ac.nz

Research Project: Preliminary evaluation of a model train community initiative

I have read and understood the Information Sheet regarding the above research project and do **NOT** give consent to participate in this research project.

Name or description

Date:

Helpful Resources

Appendix H



If you are finding yourself stressed, we have compiled a list of resources and programmes available online that we hope may help you on your journey.

- Whaikaha – Ministry of Disabled People
 - <https://www.whaikaha.govt.nz/support-and-services/specific-disability-services/autism-support-services>
- Triple P – Positive Parenting Programme

- Raising Children – the Australian parenting website
 - <https://raisingchildren.net.au/autism>
- Autism NZ
 - <https://autismnz.org.nz>
- Altogether Autism
 - <https://www.altogetherautism.org.nz>



The 1737 number is a 24/7 phone service where you can talk with or text a trained counsellor: text or dial 1737

Lifeline Aotearoa. Speak with qualified counsellors or trained volunteers
0800 543 354 (0800 LIFELINE) or free text 4357(HELP)

If you find distress, depression and despair are becoming too intense or overwhelming, Samaritans are a 24/7 crisis helpline. Samaritans is a charity organisation, and you will speak to volunteers from a variety of backgrounds.

Group 1 Observation sheet

Date-

Appendix I

Interacti on w/ trains																			

Soc Inter																			

Enviro B

Interacti on w/ trains																			

Soc Inter																			

Enviro C

Interacti on w/ trains																			

Soc Inter																			

Code

- Child initiates interaction with adult- C>A
- Child initiates interaction with volunteer- C>V
- Adult initiates interaction with child- C<A
- Volunteer initiates interaction with child C<V
- Child interacts with another child- C

Group 3 Observation sheet

Appendix J

Joint attenti on																			

Soc Inter																			

Int w/ Train s																			

Parall el play																			

sharin g																			

Group one interview**Appendix K**

Question number	Short response
1 do you come here often?	
2 why do you like coming here?	
3 what benefits do you think this facility has?	
4 are you happy to tell me a little bit about yourself?	
5 do you live locally?	
6 are any of your children neurodivergent? Do they have a disability?	
7 would you be willing to participate in an in-depth case study?	

Group three interview**Appendix L**

Question	Answer
How many children do you have and what are their ages?	
Would you say your child is neurodivergent?	
If so why is that?	
Do they have or are waiting on a diagnosis?	
If so what is the diagnosis?	
By whom and when were they diagnosed?	
Do they receive any additional help/ intervention/ attend a different school?	
What is your child's biggest need/ your greatest concern?	

Focus group interview question**Appendix M**

- How long have you been interested in model trains?
- What aspects of them pique your interest?
- Do you enjoy teaching the children how to use them?
- How do you teach them how to use the trains?
- Do any of the kids ask questions? If so, what are these questions like?
- What role do the parents play?
- What does being in this group of people make you feel?
- What are the benefits you have noticed from participating in this club?
- What benefits have you seen for others when visiting this club?
- Have you made any close friendships or bonds due to this club?
- Is there anything else you would like to mention that we have not asked?

KEY

Environment- A, B, C

Appendix N

TC pointing Joint attention	TC following
JA>A- adult	JA<A- adult
JA>C- child	JA<C- child
JA>V- volunteer	JA<V- volunteer

TC initiating SI Social interaction	Other initiating SI
SI>A- adult	SI<A- adult
SI>C- child	SI<C- child
SI>V- volunteer	SI<V- volunteer

TC initiating SH sharing	Other initiating SH
SH>A- adult	SH<A- adult
SH>C- child	SH<C- child
SH>V- volunteer	SH<V- volunteer