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Teaching Children with Autism Spectrum Disorder with Restricted Interests:

A Review of Evidence for Best Practice

Kerry G. M. Gunn & Jonathan T. Delafield-Butt*

School of Education, University of Strathclyde, Glasgow, Scotland, U.K.

* jonathan.delafield-butt@strath.ac.uk

Abstract

Inclusive education requires teachers to adapt to children's learning styles. Children with autism spectrum disorder bring challenges to classroom teaching, often exhibiting interests restricted to particular topics. Teachers can be faced with a dilemma either to accommodate these restricted interests (RIs) into teaching or to keep them out of the classroom altogether. In this article, we examined all peer-reviewed studies of teaching children with autism spectrum disorder with RIs published between 1990 and 2014. We find that positive gains in learning and social skills can be achieved by incorporating children's RIs into classroom practice: Of 20 published studies that examined 91 children, all reported gains in educational attainment and/or social engagement. Negative consequences were limited to a decrease in task performance in one child and a transient increase in perseverative behaviors in two children. The evidence supports the inclusion of RIs into classroom practice. Methods of inclusion of RIs are discussed in light of practical difficulties and ideal outcomes.

Keywords: restricted interests, repetitive interests, autism, inclusive education, classroom practice

Teaching Children with Autism Spectrum Disorder with Restricted Interests:

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Recent policy developments promote inclusion of children with special

educational needs (SEN), including children with autism spectrum disorder (ASD), into

mainstream classrooms (e.g., Ministry of Education and Science Spain, 1994; Scottish

Government, 2010; United Nations, 1989, 2006; No Child Left Behind Act of 2001,

The Individuals with Disabilities Education Improvement Act of 2004). Inclusion aims

to improve the social and educational experiences of all children, presenting a more

pleasant and humane learning environment for everyone, as well as improving academic

attainment (Briggs, 2004). Inclusion of children with SEN may require adaptations to

the curriculum and classroom environment. In particular, children with autism have

difficulties with learning, interacting and communicating with others, using an

understanding language, thinking imaginatively and enjoying variation in activities, all

of which are essential elements in classroom practice (Autism Working Group, 2002).

Adaptive practices to the SEN of these children are therefore necessary and in some

contexts, adequate provision is enshrined in law.[1]

SEN for a particular child result from an interplay of several factors that fall

broadly into four overlapping themes, of which disability and health is only one. The

learning environment, family circumstances, and particular social and emotional needs

of the child all contribute. Importantly, the styles of teaching and classroom practice

that compose the learning environment can be a contributing factor, especially when

educational practice does not take into adequate account a particular individual's

circumstances and needs. In some cases, children with SEN may come up against

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[1] For example, Education (Additional Support for Learning) (Scotland) Act 2004.

barriers to learning and achievement as a result of an inflexible approach to the

curriculum, to a school's ethos, or to teaching and learning methods that do not adapt to

the SEN (Scottish Government, 2010).

One prominent and practical concern for inclusion of ASD children into

mainstream education is how best to work with restricted interests (RIs). These

interests are objects or topics that ASD individuals pursue with focus and intensity, for

example, demonstrating a fascination with hurricanes, that can restrict engagement with

other objects or topics (Mancil & Pearl, 2008). In this paper we take inclusion to mean

that children will be supported to work to the best of their ability and have their unique

talents valued in the classroom, with teachers striving to provide enjoyable and effective

learning experiences for all.

The restricted and repetitive interests of children with ASD pose particular

challenges to teachers in mainstream settings. They can obstruct normal classroom

practice and prevent curriculum teaching. And importantly, there is no consensus on

how best to work with RIs in the classroom. On one hand, some teachers discipline and

prohibit restrictive and repetitive interests to encourage social norms and learning. On

the other, some encourage learning through RIs and incorporate RIs into lessons. Still

others follow established curricula and only allow indulgence in an RI as a reward for

task completion or good behaviour. Each approach is understandable, but relies on

different sets of understanding about the nature of RIs and how they are best avoided or

included in learning. On the one hand, RIs can be viewed as pathological expressions to

be contained and reduced, and on the other they can be viewed as particular, if not

idiosyncratic expressions of an individual's personality and agency.

The aim in this paper is to clarify the role of RIs in inclusive, mainstream educational practice to provide mainstream teachers with the information they need to make an informed decision about the best way to work with RIs in the classroom. It summarises contemporary theory and educational research on the role of RIs as an autistic expression that may provide a way in to learning, and in doing so identifies a need for further research on the technique and efficacy of working with RIs in classroom practice. This paper gives insight into the nature of RIs, reviews available research on methods of working with RIs in the classroom, and concludes with reasoned suggestions for best practice with RIs within inclusive, mainstream educational settings. This paper reviews all available evidence published between 1990 and 2014 in the peer-reviewed scientific literature on teachers' use of RIs of children with ASD, for learning and social skills enhancement and investigates various methods of incorporating these into the curriculum to enhance classroom teaching and learning.

Restricted Interests and Autistic Spectrum Disorder

Restricted interests (RIs) are a component of the formal diagnosis for ASD categorised under "restricted and repetitive behaviours" impairment (APA, 2013). Kanner published the first descriptions of autism in case histories of eleven children he described as demonstrating "an extreme autistic aloneness." (1943, p. 242). One year later Asperger (1944/1991) wrote of the severe social problems some children face, explaining they fail to show an interest in others and give poor eye contact when speaking or being spoken to. Asperger also mentioned the presence of stereotypic behaviours and RI. In 1980, the third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM) formally recognised ASD (APA, 1980), and its revised form (DSM-III-R) based the diagnosis on three impairments: (a) social impairment, (b)

communication and imagination impairment and (c) *restricted and repetitive behaviour and interests* (Happé, 1994).

Inclusion of RIs in the formal diagnosis for ASD has remained, withstanding subsequent versions and revisions incorporating new research, in the DSM-IV and DSM-IV-TR (APA, 1994, 2000; Dziegielewski, 2010). Many specialists considered autism to be a spectrum disorder and Asperger's syndrome a mild or high-functioning form of autism (HFA; Mayes and Calhoun, 2003). Ozonoff, South, and Miller (2000) argued they have the same fundamental symptoms varying only in intensity or severity. This point was recently formally adopted into the new edition, DSM-5, which eliminated Asperger's syndrome and replaced it with a diagnosis of a high-functioning or less severe expression of ASD. DSM-5 further reduced the triad of impairments to only two: (a) social communication/interaction and (b) *restricted and repetitive behaviours* (APA, 2013).

Are Restricted Interests Helpful or Harmful?

RIs are typically thought of as being abnormal and difficult to eliminate (Baker, Koegal, & Koegal, 1998). They can interfere with an individual's ability to function on a daily basis (Boyd, Woodward, & Bodfish, 2011) and have the potential to limit interactions with peers and opportunities to learn (Stocco, Thompson, & Rodriguez, 2011). RI can be pursued with intensity and children may spend a great deal of time gathering facts and information about a topic, sometimes to the exclusion of other activities. In this way, RIs can appear obstructive and problematic, in other words they appear to be something to remove or eliminate (Baker et al., 1998). Yet, a child's development of an RI involves significant child-led, self-motivated learning. A child may begin to develop his or her RI by collecting desirable objects related to it, and

progress to collecting information about the interest. This progression requires

engagement in a topic, motivation to develop knowledge and understanding about it,

and employment of psychological and material resources to do so. In other words,

following an RI may enlist principal components of learning.

The passion an individual with ASD has for his or her interests often appears to

increase with time (Charlop, Kurtz, & Casey, 1990). This passion can stimulate a child

to further develop their learning about their RI, but it can also be detrimental when

taken to an extreme. For example, it has been reported that teenage individuals may

become extremely interested in a person. This interest is often viewed as a "crush" but

the intensity of the interest can lead to problems, for example, apparent stalking

(Attwood, 2003). Thus, RIs can both facilitate learning or act as an obstruction to

engagement within socially acceptable norms.

Detrimental features of RIs lead to the belief that RIs need to be corrected, or

removed in order to facilitate recovery and learning (Charlop-Christy & Haymes, 1996).

However, an alternative perspective is that RIs are the best possible expression of an

individual's interests, and the nature of the restricted or repetitive occurrence is

symptomatic of an underlying pathology, but is not the pathology itself. In this best

performance model (cf. Brazelton & Nugent, 1995), RIs can be viewed as useful

expressions of interest that can utilise and therefore expand cognitive skills, social

sharing and cooperativity, and emotional or arousal self-regulation.

These interests differ from a typical hobby as they are abnormal in either

intensity or focus (Attwood, 2007), but appear to have similar benefits. Through them,

children with ASD can demonstrate unexpected strengths in fine-motor skill, sensory

acuity, emotional understanding, executive function, and social and communication

skills (Winter-Messiers et al., 2007). Indulging in RIs can help children to relax,

overcome anxiety, experience pleasure, and make better sense of the physical world

(Attwood, 2007).

The objects of interest within RIs range from common to eccentric ones

(Winter-Messiers et al., 2007). For example, some individuals may be fascinated by

trains (Porter, 2012) whereas others may be interested in lawn-mowers (Attwood, 2007)

or toilet brushes (Attwood, 1998). They are often intrigued by order, symmetry, and

statistics (Attwood, 1998). Attwood (2007) explained that these interests may be age-

appropriate, for example, an interest in Thomas the Tank Engine in pre-school.

However, where a typical child would replace this interest as she matures, a child with

ASD may remain fascinated with the same topic or object late into their teenage years.

RI is one of the many names for this type of behaviour. Others include intense

interests, obsessions, special fascinations, fixations, circumscribed interests,

circumscribed topics, repetitive and narrow interests, and special interest areas (Winter-

Messiers, 2007). Further, RIs can be categorised by their high- or low-level behaviours

where high-level behaviours typically reflect higher mental ability and are expressed in

complex behaviours that engage the RI, whereas low-level behaviours typically reflect

lower developmental ability and are expressed in simpler behaviours and actions

(Turner, 1999). RIs are more prevalent in individuals at the higher functioning end of

the autistic spectrum and especially in Asperger's syndrome (by DSM-IV classification)

where 90% of individuals exhibit RIs (Attwood, 2003; Leekam, Prior, & Uljarevic,

2011). RIs have been found to be less prevalent in preschool children with lower

cognitive abilities (Mayes & Calhoun, 2011). This may be due to the more limited

capacity in low-functioning children to develop abstract conceptual thought, leaving the

restrictive and repetitive nature of autism confined to simpler, under-developed behaviours, rather than more intellectual interests. Low-level repetitive behaviours may be suppressed in individuals with autism with higher mental ability and greater social awareness of their obtrusion (Mayes & Calhoun, 2011; Turner, 1999), or sublimated into more complex interests and actions.

Teachers may try to discourage children from engaging with their RI, as they believe it may hinder social interaction (Attwood, 2007), progress on academic tasks, and cause them to become disruptive (Earles-Vollrath, 2012). However, it has also been suggested that RIs can act as motivators for children with ASD, suggesting positive gains may be obtained in working with RIs (Spiker, Lin, Dyke, & Wood, 2011). To date, there has been no comprehensive assessment of whether or not working with RIs in the mainstream classroom is actually disruptive or beneficial, and opinion appears to differ from teacher to teacher. The question we seek to address here is, what is the evidence for and against the inclusion or exclusion of RIs of children with ASD in mainstream classroom practice?

Including Children with Restricted Interests in the Mainstream Classroom

This is a particularly important and timely consideration given continued growth of inclusive education, supported by policy and practice developments internationally. In the United States, the Individuals with Disabilities Education Act Amendments of 1997 guaranteed education for children with SEN in the "least restrictive environments", and has progressively increased the rates of inclusion. IDEA has continued Federal Government commitment to ensure teachers are adequately qualified to teach SEN children. In Finland, children with SEN may be included in mainstream class with an option for additional part-time special education, but all SEN pupils will

have an individual learning plan. The school curriculum can be adjusted to suit the

needs of the child to give a child-led curriculum that ranks amongst the world's most

successful (Sahlberg, 2011). Similarly, Scotland's new Code of Practice (Scottish

Government, 2010), Getting it Right for Every Child (GIRFEC; Scottish Government,

2012), and Curriculum for Excellence (Scottish Executive, 2004) state additional

support should be integrated into daily educational practice to ensure SEN children are

not singled out, to allow them to reach their full potential to improve life chances, and

to do so by valuing the talents of all children, including those with SEN.

The inclusive classroom, where all learners are supported by recognition,

acceptance, and respect of differences among them, aims to build on similarities among

children to meet learning needs and overcome barriers to learning (Hamill & Clark,

2005), in agreement with current inclusive policy. This position is in contrast to an

integrated classroom, which is discouraged, where focus is on changing the learner to

"fit in" (Rieser, 2008, p. 49). Thus, attention to an individuals agency and adaptive

teaching practice are important skills for effective inclusive education.

Myers, Ladner, and Koger (2011, p. 517) argued that at present "educational

practices both alienate students with autism from their neurotypical peers and compel

students to hide their autistic traits, when both strategies contribute to poor self-esteem

among students with autism." In the United Kingdom, Her Majesty's Inspectorate of

Education (HMIE, 2007) stated the importance of working outwards from a child's

interests and needs to effectively engage their attention and curiousity for learning, and

in Scotland, new Curriculum for Excellence policy advocates an inclusive approach that

attends to an individual's sense of agency and identity in education to foster confidence

and creative social contribution (Scottish Executive, 2004). In educational practice,

recognition of a child's motives and adaptation to them involves valuing a wide range

of abilities, talents and achievements. In this way, barriers to teacher-pupil engagement

and therefore the child's learning can be removed, increasing the child's self-esteem and

scholastic success. Underpinning this shift in orientation is an appreciation of the

beneficial value of diversity in society, and an opposition to discrimination (HMIE,

2002). Further, HMIE (2009) set out priorities to improve the outcomes of all learners,

particularly those who are disadvantaged. It suggests teachers personalise support and

learning to meet the circumstances and choices of individuals and find innovative ways

to meet the needs of their class, whilst making clear they have high expectations.

Incorporating the RI of ASD children into the curriculum could be a new and

creative way to meet these needs. It personalises learning and takes the circumstances

of ASD children into account, while focusing on their possible strengths rather than

their apparent weaknesses. For example, Winter-Messiers (2007) concluded from

extensive interviews and study of ASD children and their parents that the RIs of

children and young people with ASD can be inseparable from their self-image. She

found that children were extremely negative about themselves, with the exception of

their RI. They seemed to have a more positive view of their self-image when taking

part in activities associated with their RI, as they were able to control their involvement

and knowledge and show expertise. Thus, if teachers ignore the importance of a child

or young person's RI, they could be denying that individual an important aspect of their

identity and a means with which to encourage engagement and self-confidence.

Focusing on a child's deficits puts them at risk of depression and academic failure and

reduces their motivation to learn (Bianco, Carothers, & Smiley, 2009).

On the basis of these policy and practice concerns, and given the need to establish the evidence base for best practice with children with ASD with RIs, in this paper, we examine the evidence for and against inclusion and exclusion of RIs of children with ASD in classroom practice.

Method

To provide an overview concerning the question of whether using the RI of ASD children in the mainstream classroom can improve their learning or social skills, we conducted a broad literature search that aimed to identify all available published peer-reviewed journal articles reporting on empirical studies on this topic. We reasoned that specific focus on the peer-reviewed literature would provide the most reliable data on the effects of including RIs in teaching and learning. Further, since both negative and positive effects of RI inclusion are equally important and publishable, publication bias in one direction or the other is unlikely. Thus, this review provides the best possible survey of both positive and negative effects of RI inclusion in educational contexts.

Search Process

First, we conducted advanced electronic searches of the following databases: Web of Science, EBSCO Host (containing the Education Resource Information Centre, British Education Index, and PsycINFO databases), Australian Education Index, and SAGE Journals. We also searched the journal, TEACHING Exceptional Children Plus. The terms, *intense, special, fascination, fixation, narrow, repetitive, obsession, perseverative, ritualistic, circumscribed, restricted,* and *interest* were used, in combination with the terms *autism* or *Asperger*, as well as *social* or *academic*. The returned papers were sorted by relevance and the abstracts of all articles containing

autism or *Asperger* in the title were screened manually until it was clear that the

publications were not related to the study (i.e., they contained the search terms but in a

different context). Citations in the articles that were included were also examined.

Studies published between 1990 and the autumn of 2014 were included in this literature

review.   These limits were set as it was not until the early 1990s that mainstream

schools began to provide opportunities for ASD children to be included (Cohen, 1998;

Irish National Teachers' Organisation, 2003). The literature searches were carried out

in the winter of 2013 and again in the autumn of 2014.

Web of Science (http://apps.webofknowledge.com) provided the option to

narrow search results by selecting relevant research areas. We made use of this feature

and selected "education - educational research." In this database, the search returned

419,523 papers, with eight qualifying for inclusion. EBSCO Host

(http://search.ebscohost.com) provided the option to search a number of databases. We

chose to search Education Resource Information Centre database, the British Education

Index, and PsycINFO for comprehensive coverage of educational and psychological

research within this service. We were then provided with the option to narrow down the

results by selecting relevant major subject headings. We opted to do this and selected

"autism and education." This search returned 411 papers in 2013 and then 636 papers

in 2014. "Narrow" and "interest" were searched first alongside the other search terms

and then intense and fixation again alongside the other search terms. Of these papers

two articles qualified for review.

The Australian Education Index (http://search.proquest.com/index) provided the

option to narrow down the search results by subject. We made use of this feature and

selected adolescent, child, young adult, and children. This database also allowed one to

select words in the title; we selected autism or Asperger. This search returned 65,541

papers, of which five qualified for review. SAGE Journals (http://online.sagepub.com/)

provided the option to narrow down search results by selecting relevant disciplines. We

made use of this feature and selected: Education, Psychology and Counselling and

Special Education. This search returned 1,211 papers. Of these papers three qualified

for review. TEACHING Exceptional Children Plus

(http://journals.cec.sped.org/tecplus/) returned seven papers. All abstracts were read

and two papers qualified for review. In total 20 papers were selected for review.

Inclusion Criteria

To be selected for the review, the identified articles had to meet the following

criteria for inclusion:

1. The study focused on children or young people. Due to the variations in

    definitions of children and young people, an age criterion was also applied.

    Therefore, to be included in the review, the article had to contain participants

    between the ages of 2 and 21, inclusive.

2. The publications had to be empirical examinations of children's or young

    people's RIs in teaching or learning situations. In this paper, we take teaching

    or learning situations to mean any situation in which children are developing

    social or academic skills either on their own or with a more capable other, for

    example, at school, an after-school club, playing with a friend or sibling, or

    learning something new at home.

3. Studies had to contain outcomes of achievement in terms of academic, cognitive,

    social, or emotional skills. These outcome data could be quantitative or

    qualitative.

4. The methods applied needed to allow some conclusions to be drawn about the effect that the use of an RI to aid learning and social skills development had on children with ASD. Analyses that used a baseline level to show the growth of the achievements of ASD children were appropriate, as were more descriptive studies.

5. The study had to have been peer-reviewed, so that the studies met a minimum standard of quality and reliability in the view of other scholars.

6. The article needed to be published in English.

Coding and Interpretation

All included studies were reviewed with regard to the effect of RI on academic, cognitive, social, or emotional skills of ASD individuals. Study results were interpreted as indicating a *positive effect* on the academic, cognitive, social, or emotional skills of an ASD individual when the study reported a measured (a) improvement in academic attainment, social engagement, and/or emotional regulation or valence, and/or (b) reduction in aberrant behaviours, for example, stereotypy, delayed echolalia, etc. The results were interpreted as showing a *negative effect* on the academic, cognitive, social, or emotional skills of an ASD individual if the study reported a measured (a) decrease in academic attainment, social engagement, and/or emotional regulation or valence, and/or (b) an increase in aberrant behaviours. Twenty papers were retrieved and reviewed. All studies included reported either a positive or negative effect (i.e., there were no studies that reported no change).

Additional data to give a summary of the studies and their context were extracted from the papers and presented in Table S1 (online only): number of subjects in each study, the topic of the RIs reported, study design, and RI inclusion outcome

measures and results. Further details were extracted and presented in Table S2 (online only) to give more specific information: the children's age; ASD severity, Adaptive Functioning, or IQ; method of intervention; and more specific details on the outcome measures and results, including performance metrics and the scores achieved over the course of the study. All summary data were extracted by the first author and verified by the second author. A special effort was made to preserve the objective details of the data within the tables for balance and transparency. Thus, these tables summarise both negative and positive RI inclusion effects, and contain details about the study designs, measurements employed, and study results.

Due to the small number of studies ($N = 20$), results should be interpreted with caution. Furthermore, we sought to ensure a sensitive and cautious approach by reporting all negative, neutral, or questionable results identified in the literature. These are clearly identified in Tables S1 and S2, and presented and discussed below.

Results

All 20 papers reported positive gains in learning, communication, social engagement, or behaviour or emotional well-being when incorporating RIs into teaching and learning. Two papers presented some negative effects of inclusion of RIs in engagements with children with autism, alongside positive gains. In sum, the weight of evidence suggests that including RIs when working with children with autism results in positive outcomes with only minor or negligible disadvantages to the children.

Beneficial effects outweigh detrimental effects. We first consider the evidence against inclusion of RIs in classroom practice with caution: one study found that perseverative behaviours may increase for a time before decreasing again, two found that after experimental sessions inappropriate behaviours may increase, and evidence

from one child with a decrease in task performance suggests reduced performance may

be an important consideration (Charlop et al., 1990; Charlop-Christy & Haymes, 1996;

Kryzak, Bauer, Jones & Sturmey, 2013). In particular, Charlop et al. found that

perseverative behaviours of two children (of three) increased by a small amount (ca.

0.75%) when the experimental conditions were started. However, after this initial

increase, a decreasing trend resulted in an overall positive effect.

Charlop-Christy and Haymes (1996) carried out a study in which they aimed to

increase the task performance of four children with ASD. Although three of the four

children improved in task performance, one child's performance decreased from 66% to

60%. However, in their explanation of these results the authors attributed this decline to

a wider concern: the child was failing to respond and not making progress with

academic tasks during non-experimental therapy sessions, too. They reasoned the

decrease in task performance was not linked to the use of RIs as reinforcers. In their

study, the inappropriate behaviours of another child increased during non-experimental

sessions. The authors suggest this was due to a new situation with reduced access to

their RI. Finally, Kryzak et al. (2013) found that one child in their study increased on a

ratings of RI intensity scale. After intervention they increased by one point on the

difficulty interrupting or redirecting and interference with socialising areas, suggesting

an increased restrictive attention to the RI. However, alongside these shortcomings

were reported larger gains of two or more points in happiness in interaction and interest

in engagement, as well as gains in engagement generally.

The likelihood of negative effects when engaging in RIs is an important

consideration, but taken into context these effects do not exclude the possibility of

including engagement with RIs for overall benefit and effective classroom practice.

Indeed, two of the three studies that reported detrimental effects showed these to be initial, temporary ones, reporting improved task performance and reduction in inappropriate behaviours over the course of study, or indeed not directly associated with RI inclusion at all.

In what follows, we review the data retrieved, demonstrating positive gains in motivation, task engagement, task performance, as well as in social engagement, social skill, confidence and emotional well-being. We discuss the implications of the evidence both for and against inclusion of RIs in classroom practice. First, we present two different methods presented in the literature for inclusion of RIs, based on approaches for intrinsic and extrinsic reward.

Inclusion of Restricted Interests Improves Positive Outcomes

Of the papers retrieved, all 20 demonstrated gains in motivation and engagement, 6 showed improvements in task performance, and importantly 15 papers demonstrated that social engagement and social skills improved when RIs were incorporated into the teaching of ASD children.

Motivation, task engagement, and task performance. Motivation is an important condition for successful learning (McLean, 2003). The reports retrieved reported that it is often difficult to find ways to motivate children with ASD (Charlop et al., 1990; Charlop-Christy & Haymes, 1998). Children with ASD do not respond to events that interest typically developing children, especially social rewards such as praise (Charlop et al., 1990). However, some papers suggested that ASD children find the pursuit of their RI to be reinforcing and intrinsically motivating (Baker, 2000; Baker et al., 1998; Boyd et al., 2007; Charlop-Christy & Haymes, 1998; Charlop et al., 1990; Koegal, Singh & Koegel, 2010; Mancil & Pearl, 2008; Spencer, Simpson, Day &

Buster, 2008; Winter-Messiers, 2007). For example, Mancil and Pearl (2008) observed

a second grade teacher incorporating a girl's interest of Thomas the Train™ into the

curriculum using simple strategies, for example, by providing books about Thomas or

putting his picture on math flashcards. Improvements in reading, math and science

were made in a few weeks. After using Thomas books for a couple of months the

child's comprehension and fluency had improved from a 1st to 2½ grade reading level.

Koegal et al. (2010) incorporated choice and RI into the academic tasks of four

children with ASD. The study took place in their homes and at their after-school

programme. Results showed that providing choice (e.g., asking where they would like

to work) and incorporating their RI into tasks appeared to make them less likely to put

off doing tasks, maintained interest, improved their rate of performance and helped

decrease disruptive behaviour. A boy in their study progressed from demonstrating

disruptive behaviour when asked to complete math or writing tasks to repeatedly

requesting to do more. The authors suggested that the children may have been more

motivated to learn under these conditions.

Engagement in tasks increased when the RI was included. Children with ASD

often had problems engaging with academic tasks (Mancil & Pearl, 2008), showed little

interest in them and became disruptive when asked to complete one (Koegal et al.,

2010). However, incorporating RIs into academic tasks improved the engagement and

motivation of ASD children, encouraging them to complete less preferred or

challenging activities (Mancil & Pearl, 2008).

Using RIs increased task performance. Incorporating the interests of children

with ASD into the curriculum improved their academic performance (Charlop-Christy

& Haymes, 1998; Lanou, Hough, & Powell, 2011; Mancil & Pearl, 2008). The data

retrieved suggested that incorporating the RI of ASD children into their academic tasks can allow them to show their true level of ability by unlocking their potential, as they are motivated to engage in these tasks and may be unmotivated to engage in other tasks (Mancil & Pearl, 2008; Winter-Messiers, 2007).

Disruptive behaviours can prevent children with ASD from meeting educational goals (Koegal et al., 2010; Lanou et al., 2011). Thus, it was suggested that incorporating RIs into academic tasks might decrease inappropriate and disruptive behaviour (Charlop-Christy & Haymes, 1998; Koegal et al., 2010). Charlop-Christy and Haymes (1998) used the consequence-based approach to successfully increase the correct responses of three children with ASD, while also appearing to decrease their inappropriate behaviours. The study took place at an after-school behaviour programme. During the experimental sessions RI were used as token reinforcers for example, one child was given a micromachine card when he gave a correct response, whereas during the baseline phase a typical token was given, for example, a star. In both cases after five tokens had been earned the children traded these in for the same backup reinforcer, for example food. Increasing RI use in these cases decreased disruptive behaviour and improved learning.

Social engagement. ASD children often have problems with social behaviour, actively avoid social contact, and seem unmotivated to interact with others (Baker et al., 1998). Importantly, they fail to initiate joint attention with others (Bruinsma, Koegel, & Koegel, 2004), an essential ability for learning is involving co-ordinated intersubjective attention with another person to an event or object of shared interest (Delafield-Butt & Trevarthen, 2013; Tomasello et al., 2005; Trevarthen & Hubley, 1978). Inclusion of children's RIs (letters and numbers) was found to promote language development, help

children understand the viewpoints of others and how to behave socially and participate meaningfully in conversations (Vismara & Lyons, 2007). Vismara and Lyons (2007) suggest that ASD children are capable of producing joint attention, but they might not not have the social motivation to do so. Thus, they carried out a study that used a single-subject reversal design in which treatments were alternated to examine whether or not three young children with ASD would initiate social sharing through joint attention. They combined the motivational techniques of Pivotal Response Treatment (PRT) with stimuli relating to their RI. PRT is a naturalistic treatment program for ASD, derived from ABA approaches. The intervention uses strategies such as child choice, interspersing maintenance tasks, task variation, the use of direct and natural reinforcers and rewarding attempts. It makes use of operant teaching principles (Mohammadzaheri, Koegal, Rezaee & Rafiee, 2014). The results show an instant increase in all of the children's joint attention initiations. The authors explained that this type of intervention helps ASD children use their RI in a socially acceptable manner and does not cause negative side effects (Vismara & Lyons, 2007).

However, Kluth and Schwarz (2008) explained that children with ASD may find it difficult to move away from activities related to their RI if it is incorporated into the curriculum. They may tantrum (Charlop-Christy & Haymes, 1998; Sarris, 2012), become angry (Attwood, 2007), agitated or anxious when someone limits access to, or conversation about, their interest (Boyd et al., 2011). It has been shown, in contrast, that incorporating RI into academic tasks can decrease or eliminate inappropriate behaviours overall (Koegal et al., 2010). It is also possible for these frustrations to be lessened when using RIs as reinforcers (Charlop-Christy & Haymes, 1996, 1998). However, it is worth noting that when using RI as reinforcers, Charlop et al. (1990)

reported an initial increase in the perseverative behaviours of two of their three participants before these returned to previous levels.

Data suggest RIs can be used to improve the communication and social skills of children with ASD (Davis, Boon, Cihak & Fore, 2010; Spencer et al., 2008; Winter Messiers, 2007) and Koegal, Vernon, et al. (2012) suggest that the more general interests of children with ASD may also be used. Children with ASD showed greater competence in social interaction when the interaction was related to their RI (Dunst et al., 2011; Koegal, Fredeen, et al., 2012; Winter Messiers et al., 2007) and in 23 interviews with individuals with ASD, Winter Messiers et al. (2007) discovered that, when engaged in their interest, children with ASD were able to perform better in areas considered to be ASD deficits. For example, when talking about their interest, children with ASD spoke fluently, used a wide range of vocabulary, improved their interpersonal conversational skills (increased eye-gaze) and improved their body language (becoming more enthusiastic and animated about what they were saying, decreasing fidgeting and orientating their body to the interviewer).

Koegal, Vernon, et al. (2012) assessed whether the social skills of three children with ASD could be improved by incorporating their general interests into lunchtime clubs. An activity preference assessment was carried out and when a list of interests had been gathered the clinicians and parents worked together to decide which of the target child's interests would also appeal to their peers. The interventions involved a social club being put in place based on their interests. An adult was responsible for introducing the daily club activity and then took a step back. Participation in these clubs was voluntary for all. The results showed that during the baseline phase, none of the children spent time engaging with their peers. However, during the final

intervention phase, all of the children had increased their level of engagement maximally.

Children with ASD often struggle to understand social situations (Lanou et al., 2011). The Power Card Strategy (PCS) is an intervention that aims to capitalise on the RI of ASD children in order to promote their social skills. The strategy consists of a Power Card script and a Power Card. An adult reads the script with the child; this is written in the first person and describes the child's RI, role model or hero in a situation they have difficulties with. It then describes how the figure solves the problem by behaving appropriately. The child is also provided with a Power Card, an abbreviated version of the script, which includes rules on how to behave (Gagnon, as cited by Keeling et al., 2003). The PCS is intended for use with children who are reading within one grade level of where they are currently placed (Campbell & Tincani, 2011).

The reports retrieved suggested that the PCS is effective at increasing perspective taking (Lanou et al., 2011), direction following (Campbell & Tincani, 2011) and social interactions (Spencer et al., 2008) of ASD children and in improving their conversational (Davis et al., 2010) and sportsmanship skills (Keeling, Myles, Gagnon & Simpson, 2003).

Lanou et al. (2011, p. 179) made use of the PCS to improve a child's ability to interact appropriately with others, as the child often infringed on personal space. The script compared personal space to the Titanic colliding into an iceberg, the Titanic was endangered by its closeness to the iceberg and being too close to others could upset them. The card was placed around the classroom and read daily by the child. Whenever the child got too close a teacher or peer would say "iceberg right ahead" to remind him. There was a significant decrease in complaints about the child invading

personal space, and he could explain the importance of it to others. Spencer et al.

(2008) reported on the use of the PCS to help a five-year-old child with ASD increase

his social interactions and time spent on the playground. During baseline the child had

poor social skills and did not play with other children; he spent an average of ten

minutes on the playground with other children in his own class, but would leave when

the other classes came out. The PCS enabled him to spend an average of nine additional

minutes on the playground when the other children from other classes were also present.

He also partook in and seemed to enjoy a game of tag, communicating successfully with

his peers in the process. Furthermore he was able to take turns on the climbing wall and

slide.

Providing children with ASD with opportunities to use materials based on their

interests during play can encourage interaction with others (Porter, 2012).

Incorporating RIs into games was reported to increase their social interactions with

siblings (Baker, 2000) and peers (Baker et al., 1998; Boyd et al., 2007).

Boyd et al. (2007) carried out a study that compared the effects of less preferred

(LP) items to RI items on the social behaviours of three fully included children with

ASD. In the choice condition two peers sat holding a LP or RI item, they were asked

not to initiate but to respond to initiations. Each child with ASD chose whom to play

with six times. All children chose to play with the peer holding the RI item most or all

of the time. Next the RI and LP items were alternated. Only one peer partook and the

child with ASD had to decide whether they wanted to play with the RI/LP item alone or

with their peer. The percentage of time children spent engaged in positive social

interactions was significantly higher when their RI was present and it took them less

time to initiate play. However, the authors suggested that for the RI to be socially

motivating it may be necessary for children to have some social skills.

Baker (2000) incorporated the RI of three ASD children into a game of Bingo®.

During intervention the children were prompted to play this with their sibling.

Participation was voluntary and there were no extrinsic reinforcers. All children

showed increases in social play interactions with their sibling during intervention and in

maintenance and follow-up phases. They began to engage in other games with their

siblings that did not include their interest. After intervention all children demonstrated

large increases in positive social interactions at home and at school (two mainstream

and one part-time special education school). The positive joint attention behaviours of

the children also improved dramatically. During intervention the rating of affect

(interest and happiness) of all children increased from neutral to positive and this

remained throughout maintenance and follow-up phases. Furthermore, the obsessive

behaviours of all children decreased. Parent ratings showed that the children spent

increased amounts of time playing with their siblings and sibling interviews showed an

improvement in the perception of the ASD child.

Kryzak et al. (2013) aimed to increase the responses of three children with ASD

to the joint attention directives of others. They presented the children with ASD with

opportunities to respond to joint attention directives while they were engaged in an RI

activity. A child was considered to have mastered this task when they responded

independently, within four seconds, and to a minimum of 80% of the joint attention

directives over two sessions on two separate days. The results showed that after 19 to

29 sessions all children had mastered how to respond to joint attention directives while

engaged in an RI activity. Two of the participants maintained their mastery

performance and the other child's performance ranged from 70-90%. However according to parent ratings the RI intensity of one of the participants stayed the same or increased by only one point.

Finally, it was suggested that children with ASD can benefit from partaking in classes related to their RI (Koegal, Fredeen, et al., 2012, Koegal, Vernon, et al., 2012). Koegal, Fredeen, et al. (2012) assessed whether positive social interaction between children with ASD and their typically developing peers could be promoted by creating clubs based on the RI of the ASD participants. Results showed that ASD children went from total or near total disengagement to engaging with peers approximately 85-100% of the session.

Children also increased the frequency of initiations to their peers. Koegal, Vernon, et al. (2012) carried out a study that incorporated more general interests of ASD children into lunchtime clubs. This resulted in an increase in engagement with peers as well as unprompted verbal initiations. These improvements are not to be taken lightly, social engagement remains very difficult for children with ASD, and to seek to initiate contact is a significant social improvement that can contribute to improved opportunities and engagements for learning.

Intrinsic and Extrinsic Reward-based Approaches to Restricted Interests Inclusion

The literature presented two methods for incorporating RIs in teaching: antecedent-based (Baker et al., 1998; Baker, 2000; Keeling et al., 2003; Gagnon & Simpson, 2003; Boyd et al., 2007; Vismara & Lyons, 2007; Mancil & Pearl, 2008; Spencer et al., 2008; Davis et al., 2010; Koegal et al., 2010; Campbell & Tincani, 2011; Dunst et al., 2011; Lanou et al., 2011; Koegal, Fredeen, et al. 2012; Koegal, Vernon et al. 2012; Porter, 2012; Kryzak et al., 2013) and consequence-based (Charlop et al.,

1990; Charlop-Christy & Haymes, 1996; Charlop-Christy & Haymes, 1998; Vismara & Lyons, 2007) approaches. Antecedent-based approaches made use of the interest itself as the so-called reinforcer to encourage appropriate behaviour, for example, the incorporation of trains into maths problems for a child with an RI in trains, or asking a child to write about their RI in an assignment. On the other hand, consequence-based approaches allowed access to the RI only after a target behaviour was demonstrated, for example, allowing a child access to a book about their interest after they read an assigned reading book (Boyd, McDonough, & Bodfish, 2012). The antecedent-based approach made use of the child's intrinsic motivation to engage and learn, unlike the consequence-based approach, which drew on the child's extrinsic motivation for engagement with learning. Intrinsic motivation describes the compulsion to engage with an activity based on its inherent qualities and satisfaction derived from within the engagement itself; the individual knows they will experience pleasure from investing in the project and is therefore motivated to engage. On the other hand extrinsic motivation describes engagement in an activity for instrumental reasons, i.e., to achieve some quality above and beyond the task itself. The most common extrinsic motivator is a reward. In the case of extrinsic motivation, the person views the activity as separate from the incentive to take part, and thus the activity itself may remain unpleasant (Otis, Grouzet, & Pelletier, 2005).

Lanou et al. (2011) explained how a teacher in a mainstream class made use of the antecedent-based approach, to improve the performance of an ASD child. The child struggled with writing tasks, found it difficult to communicate his difficulties and often had meltdowns when feeling unsuccessful. A strategy was devised that aimed to build on his interests and strengths. The child often doodled in his book during writing

lessons, drawing a little line, a large line, a horseradish (his RI), and a house. He explained the pictures represented a scale from negative to positive. The teacher adapted this scale into classroom practice to encourage the child during writing tasks, and therefore to include the confidence he had with subjects around his RI. His output, writing stamina and rate of performance improved as a result.

Charlop et al. (1990) presented data to show that the consequence-based approach successfully increased three children's ability to answer questions correctly during their after-school programme. Tasks each child had been struggling with were selected for use during the experimental sessions. Permission to engage with an RI was employed as a reinforcing reward for task completion and compared with other non-RI rewards, for example, food. The results demonstrated the children performed best when access to their RI was the reinforcer. Further, the study reported that when those children engaged in their RI, they did so in a controlled manner and did not resist when the object was taken away, sometimes returning it before they were asked. Similarly, Charlop-Christy and Haymes (1996) carried out a study at an after-school programme for behaviour management. They found inclusion of the RIs of children with ASD served as an effective reinforcer to decrease inappropriate behaviours and increase task performance, and although the task performance of one of the four participants in the study decreased, this failure was not linked to the use of the RI, but to external factors. In sum, the evidence indicates incorporating RIs into academic tasks, whether as an instrinsic motivator in an antecedent-based approached or as an extrinsic motivator in a consequence-based approached, can increase task performance and improve behaviour (Tables S1 & S2, available online).

Discussion

The results presented here demonstrate beneficial gains in social engagement, task performance and learning can be obtained with inclusion of RIs into classroom practice. These can be based on either intrinsic (antecedent-based) or extrinsic (consequence-based) approaches. However, despite the success of both approaches, intrinsic reward-based approaches appear more favourable for use in the mainstream classroom. RIs incorporated into tasks are more likely to encourage engagement generated from a personal, intrinsic interest in learning or engaging with that object. Flink et al. (1992) explain that typically developing children who are intrinsically motivated are more likely to enjoy complex tasks and will aim to master them. In contrast, extrinsic reward-based methods may generate only superficial learning and can falter, as the sole reason for engagement may not be for the pleasure of the task itself, but for its extrinsic, consequent reward. Further, achievements may suffer and not be substantiated; children extrinsically motivated often avoid challenge even when a reward is offered.

Incorporating RIs into the curriculum can be as simple as including them in questions or allowing children to research non-preferred topics using preferred research methods. For example, if a child enjoys using the internet to research their RI, they could similarly use the internet to research the class topic (Winter-Messiers et al., 2007). Bianco et al. (2009) recommend using RIs as a stimulus to create interdisciplinary topics, which can in turn be used to teach many skills and widen the interest area. Teachers should be aware of the desired learning outcome of tasks, and judge whether or not a child with ASD is required to complete the same task as

everyone else to achieve the same learning outcome. For example, if the outcome is to

write in sentences, in practice it would be beneficial to allow the child with ASD to

write about their RI, rather than the topic set for the class. Such simple technique,

flexible curriculum and RI inclusion will likely enhance motivation and learning for a

child with ASD.

In some cases, it can be difficult to incorporate an RI into the task. Mancil and

Pearl (2008) suggest that motivation can be increased using a consequence-based

method by allowing access to the RI if the task is completed first. A First-Then Board

for example, allows the child to see what they need to do to gain access to their RI.

Although successful, it should be considered that this technique might prevent the child

from learning that reading can be pleasurable for its own sake, as above all they are

aiming for access to their RI.

Inclusion of RIs into classroom practice may not be possible for every child

(Charlop-Christy & Haymes, 1996). For example, not all ASD children have an RI that

can be used in the classroom (Charlop et al., 1990; Charlop-Christy & Haymes, 1996;

Vismara & Lyons, 2007). Some may be difficult to access, for example, traffic lights

(Charlop et al., 1990; Charlop-Christy & Haymes, 1996) and some are potentially

dangerous or illegal, for example, weapons (Attwood, 2007).

Practical Issues of Incorporating Restricted Interests into Mainstream Classrooms

The aim of this review was to investigate whether incorporating the RIs of

children with ASD into the mainstream curriculum can enhance their learning and

social skills. It should therefore be noted that although the results presented in the

literature demonstrate overwhelmingly favourable effects of inclusion of RIs in

educational settings, six of these papers presented results from special, not inclusive

settings. Six papers provided results about children who attend mainstream settings and another two included a combination of both. The final six papers provided results from other learning situations, such as an after-school behaviour management programme or learning in the home.

Nevertheless, translation of techniques employed in specialist settings can be made to fit mainstream classrooms. Boyd et al. (2007) report on improvements in positive social interactions with peers and initiations made to peers regardless of setting. Skills learned under specialist classroom technique can be maintained in mainstream settings (Keeling et al., 2003). However, Davis et al. (2010) explain that despite an improvement in conversational skills in their special education classroom, not all children in their study were able to readily generalise this to their mainstream class. Thus, based on the evidence presented, incorporation of RIs into mainstream practice should be considered an attractive option to be explored, as it can potentially be very beneficial for the ASD child, their peers and teacher(s), but some attention to logistics, technique and individual response should be maintained.

Further, parental perception of RIs was reported in four studies to be negative. Parents typically viewed RIs as problematic and expressed negative emotions about their children's RI (Baker, 2000). Some parents were concerned their child's RI would prevent further education or a career, were socially unacceptable, and/or were not age appropriate (Porter, 2012; Spencer, Simpson, Day & Buster, 2008; Winter-Messiers, 2007). Further, Porter (2012) found that RIs interfered with sibling and peer relationships. Cultural expectations and possible challenge to norms or beliefs must be taken into account when working with a child's RI.

The Teachers' Role in the Inclusion of Restricted Interests

Teacher attitudes toward RIs and their thoughts on inclusion of these into classroom practice determine whether or not these will be employed within useful teaching strategies. Presently, some teachers stop children from engaging with their RI in the classroom (Spencer et al., 2008), in part to afford completion of prescribed curricula (Winter-Messiers, 2007). Yet, discouraging children from engaging with their interest can generate frustration and thwart learning (Kluth & Schwarz, 2008). The evidence gathered for this study suggests inclusion of a child's RI can be intrinsically motivating and generate social engagement, with generalised positive, not detrimental effects.

However, most mainstream teachers currently receive little or no compulsory training on ASD and working with ASD children is not typically a core element in initial teacher education (e.g., ENABLE Scotland, 2011). Mancil and Pearl (2008, p. 4) explain how one teacher thought ignoring or redirecting the RI of children with ASD was the best thing to do, until she "stumbled across" an online article suggesting inclusion of RIs into classroom practice was preferable. We believe it is unacceptable that due to lack of training teachers are left to find important information such as this by chance. With the move towards inclusive education in many nations it is becoming increasingly important that teachers are made aware of ASD and how best to work with the RIs of children with ASD.

As little as three decades ago RIs were considered problem behaviours that should be eliminated (Rudacille, 2011). Charlop-Christy and Haymes (1996, p. 544) explain that some believe engaging in an RI may make children appear "bizarre." In the past people working with children with ASD relied on punitive procedures to reduce inappropriate behaviours. These ranged from milder forms, for example, time-out, to

increasingly intrusive procedures, for example, restraining the child, slapping their body, giving an electric shock, etc. (Charlop-Christy & Haymes, 1996). The tight association of restricted and repetitive behaviours with autism diagnosis led to a notion that RIs must be removed to offer therapeutic assistance. However, autism is a recognised *syndrome*, or collection of *symptoms* that consistently occur together, of which RIs are one (Hobson, 2013). RIs are *signs* of the disorder, not the cause of the disorder per se.

Autistic symptoms, especially RIs, may be compensations for underlying disruption to basic integrative sensory and motor systems that produce difficulty in regulation of emotion and attention to other persons (Delafield-Butt & Gangopadhyay, 2013; Trevarthen & Delafield-Butt, 2013). Social withdrawal and isolation inhibits and obstructs learning; it is in our interest to encourage social engagement and shared interest in the objects and projects of our world (Hobson, 2013; Mundy et al., 2009; Reddy, 2002, 2010; Roger & Williams, 2006; Trevarthen, 2012). And whether autism and a child's particular RI are due to sensory and motor disturbance (Trevarthen & Delafield-Butt, 2013), failure in theory of mind (Baron-Cohen et al., 1985, 2000), or weak central coherence (Frith, 1989/2003), the expressions of the child remain the child's expressions, no matter how unusual and idiosyncratic.

In comparison to the other impairments of ASD, RIs have only recently started to be systematically examined (Stratis & Lecavalier, 2013). Little is known about the aetiology and development of these high-level repetitive behaviours (Turner, 1999), and studies attempting to treat restricted interests are few and far between (Sarris, 2012). However, daily life can be a struggle for many individuals with ASD due to the lack of consideration of their interests by others (Mottron, 2011). Inclusion of RIs in social

engagements of all kinds appears to address the person-as-agent to facilitate social engagement and shared understanding (De Jaegher, 2013; Trevarthen & Delafield-Butt, 2013).

Conclusion

In sum, the published evidence indicates substantial benefits in social engagement, learning, and behaviour for children with ASD when their RI is included in classroom practice. It is therefore suggested the RIs of children with ASD be incorporated into the mainstream curriculum where reasonable to do so to encourage enjoyment in learning and socialising. Intrinsic reward-based methods including integrating the RI into teaching materials or tasks is deemed preferential to extrinsic, consequence-based methods, though both can be successful. Importantly, caution must be taken when including RIs into teaching practice as inclusion may not be successful for all individuals, and parental or cultural perceptions may be challenged. Nevertheless, the gains in learning and social engagement reported suggest sensitive inclusion of RIs into classroom practice is preferable to exclusion.

Working with the RIs of children with ASD can allow access to that individual's sense of self with their particular interests, motivations, and intentions – bringing the child's RI into the classroom brings the child into the classroom. Learning is made in shared engagement motivated from both sides to explore, navigate, and complete a challenge, accommodating and assimilating new knowledge and ideas. Without engaging with a child within their sphere of interest, teachers may fail to reach the passion for learning that motivates a child with ASD to engage with new experiences. Thus, including an individual's RI in classroom practice in a sensitive and informed manner can best support the child and whole classroom learning and in doing so also

satisfy international policy for best educational practice (United Nations, 2006; The Individuals with Disabilities Education Improvement Act of 2004).

The papers reviewed here represent the sum of our scientific knowledge on RI inclusion in education, but more work needs to be done. Future studies with larger sample sizes testing specific techniques of RI inclusion will afford improved understanding of how children with ASD are motivated by, and can learn through exploration of their RI. Knowledge of the role of RIs in motivation, self-regulation of interest and learning, and socio-emotional well-being will afford insight into the aetiology of ASD as well as inform broad educational means for achieving an enjoyable life of learning. A study carried out across various mainstream educational settings, including extra-curricular and home environments, could further improve our understanding and efficacy of this particular inclusive practice.

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Table S1

Summary of Advantages and Disadvantages of RI Inclusion in Teaching, Collated from All Studies Available in Peer-reviewed Literature

Published Between 1990-2014

Author(s)	Year	n	Age (years)	RIs Reported	Method	Advantages of including RI in learning	Disadvantages of including RI in learning
Charlop, Kurtz, & Casey	1990	3	6-9	• Humpty Dumpty doll, See-N-Say toy, + plastic farm animals • Trees, leaves, + books about pine trees and cactus • Lawnmowers, chainsaws, Honda cars, home improvement stores and discount stores	Experiment 3: Perseveration with specific objects employed as reinforcer to increase correct task response.	Highest percentage of correct responses in sessions in which perseverative behaviours were used as reinforcers; inappropriate behaviours of one child did not increase.	Perseverative behaviours of two children initially increased before decreasing.
Charlop-Christy & Haymes	1996	4	5-6	• Maps, globes + atlases • Toothpaste caps + plastic sticks • Plastic toy helicopters + a family photo album • Balls and balloons	Assessment of obsessions of children with autism used as reinforcers to decrease inappropriate behaviours and increase task performance.	Decreased inappropriate behaviours of all children and increased task performance of three.	Decreased task performance of one child. One child's inappropriate behaviours increased when in non-experimental sessions

				• Movies		inappropriate behaviours.
Charlop-Christy, & Haymes	1998	3	7-9	• Trucks, trains, + micromachine cards • Certain letters of the alphabet, videos, + characters from the videos • Plastic beads	RIs of children with autism used as tokens.	Motivation enhanced, academic task performance increased, and decrease in inappropriate behaviours.
Baker	2000	3	5-6	• Number lines • Cars + vacuums • Movie clips	RIs of children with autism incorporated into games played with siblings.	Positive social interaction increased and generalised to other games and settings, joint attention increased, affect improved (interest and happiness) and obsessive behaviours decreased or eliminated.
Keeling, Myles, Gagnon, & Simpson	2003	1	10	• Power Puff Girls cartoon characters	Power Card Strategy inclusion of RIs employed to teach child with autism sportsmanship skills.	Effective in teaching sportsmanship skills (generalised across settings) and decreasing inappropriate/disruptive behaviour.
Boyd, Conroy, Mancil, Nakao, & Alter	2007	3	5	• Thomas the Train™ • Toy construction truck	Compared effect of less preferred to RI stimuli on social behaviours of children with autism by incorporating them into play situations with typically developing children.	Increased time spent engaged in social interaction when RI was the stimulus and decreased latency time to first peer initiation.
Vismara & Lyons	2007	3	3-4	• Letters and numbers	Motivational techniques of Pivotal Response	Increase in initiation of joint attention, improvement in

						Treatment combined with stimuli relating to the RI of autistic children and tested for increase in initiation of joint attention with caregiver.	quality of interaction between child and caregiver, no increase in negative behaviours.	
Winter-Messiers	2007	23	7-21		• Transportation (airplanes, cars, trains + trucks) • Music (composing, drumming, rap music + saxophone) • Animals (frogs, goats + horses) • Sports (swimming) • Video games (role-playing games) • Motion pictures (Disney movies, *Star Wars*, + vampire movies) • Woodworking • Art (Anime, cartooning, manga + sculpting)	Interviews conducted with individuals with autism about their RI; eighteen surveys of parents' views.	Reported improved social, emotional, communication, sensory and fine motor skills when engaged with RIs.	
Mancil & Pearl	2008	3	5-18		• Thomas the Train™ • Hurricanes • Electronic gadgets	RI of elementary, middle and high school children incorporated into curriculum.	Improvements obtained in academic task performance and motivation.	Difficulty embedding RI into some tasks; one teacher thought it best to ignore or discourage RI engagement.

Spencer, Simpson, Day, & Buster	2008	1	5	• Lightening McQueen (a character from the Disney movie *CARS*)	Power Card Strategy inclusion of RIs employed with child with autism to help increase playground engagement and social interactions.	Increased play time in the playgrounds, improved social interaction and communication, easy to implement.
Davis, Boon, Cihak, & Fore	2010	3	14-18	• The Atlanta Braves baseball team • Yu-Gi-Oh • College basketball	Power Card Strategy inclusion of RIs tested for social initiation and conversational skills.	Increase in engagement in conversations about interests of typically developing peers.
Koegel, Singh, & Koegel	2010	4	4-7	• Maps	RIs of children with autism and specific motivational variables incorporated into academic tasks.	Improved performance rate, reduction in putting-off task engagement, maintained task interest, and decreased disruptive behaviour.
Campbell & Tincani	2011	3	6	• Carla (a character from the Starfall educational website) • Trains • Carl and Russell (characters from the Disney movie *Up*)	Power Card Strategy inclusion of RIs evaluated on ability of children with autism to follow directions and evaluate satisfaction of classroom staff members.	Increased direction following of all children.
Dunst, Trivette, & Masiello	2011	17	2-6	• N/A	Explored influence of participation in interest-based learning activities on the development of pre-schoolers with autism.	Teachers satisfied with the intervention and reported improvements in social skills of children with autism, easy to implement.
Lanou, Hough,	2011	4	School	• Horseradish	RIs of children with	The more interest-based the

& Powell			age	• Maths • The Titanic	autism in upper elementary classes used to help them meet challenges in school.	learning opportunities, the greater the progress made over a short period of time in language, cognitive and social domains.	
Koegal, Fredeen, Kim, Danial, Rubinstein, & Koegal	2012	3	11-14	• Movies • Comic books and cartooning • Card games	Lunch club interest-based intervention established for children with autism.	Decreased negative behaviour, increased pro-social behaviour, increased ability to communicate, and improved compliance.	
Koegal, Vernon, Koegal, Koegal, & Paullin	2012	3	9-12	• Animated television characters + board games • Cooking, arts, + crafts • Video games + video game strategy guides	Lunch club interest-based intervention assessed for improvement in social skills of children with autism.	Marked increases in social engagement and social initiation with typically developing peers.	
Porter	2012	1	5-8 (study lasted 3 years)	• Trains	Parent used RIs of one pre-school child with autism to increase their engagement in pretend play.	Increased engagement with peers and unprompted initiation of verbal engagements.	
Kryzak, Bauer, Jones & Sturmey	2013	3	3-14	• Reading and books • BMW catalogue and toy cars • Trains	RIs used in an attempt to increase responding to others' joint attention directives.	Responding to the joint attention directives of others' increased for all children.	Small increase in RI intensity for one participant.

Table S2

Detailed Summary of RI Intervention Type, Outcome Measurements, and Significance, Collated from All Studies Available in Peer-

reviewed Literature Published Between 1990-2014

Author(s) and Year	Age	Gender	ASD Severity / Adaptive Functioning / IQ	Intervention Type	Outcome Measure	Quantity / Significance of Gain of Outcome Measures Negative Outcomes Indicated with an Asterisk (*)
Charlop, Kurtz, & Casey (1990)	6-9	3 males	Mental age (3.1-4.5yrs) Verbal	RI as reinforcer in task learning	Cognitive task performance (% correct) Aberrant behaviours (mean % intervals of occurrence)	Baseline scores: 50-60% Intervention scores: 80-95% *Stereotypy* Baseline scores: 5-70% Intervention scores: 3-30% *Off-task behaviour* Baseline scores: 1-40% Intervention scores: 1-5% *Perseverative behaviours* Baseline scores: 0.25-10% Intervention scores: 1-2.5% *Perseverative behaviours of child 2 and 3 increased minimally (by approx. 0.75%)
Charlop-Christy & Haymes	5-6	3 males 1 female	Mental age (2 untestable + 1 child 129 based on	RI as reinforcer in task learning	Cognitive task performance (% correct)	Baseline scores: 60-75% Intervention scores: 60-90% *One child's task performance decreased from 66% to 60%

(1996)			Leiter International Performance Scale) 1 x non-verbal 3 x verbal		Intervals of inappropriate behaviours (%)	Baseline results: 27-50% Intervention results: 6-30% *Inappropriate behaviours of one child increased during non-experimental sessions (after taking part in RI as reinforcer sessions)
Baker, Koegel, & Koegel (1998)	5-8	1 male 2 females	2 x Vineland Adaptive Behaviour Scales adaptive behaviour score of 65 1 x IQ 107 3 x verbal	RI incorporated into playground games to encourage social interaction	Social interactions (%) (mean) Mean rating of affect (higher scores indicate positive interest and happiness)	Baseline scores: 2-19% Intervention scores: 66-100% Maintenance scores: 70-88% when playing obsession theme games and 56-97% when playing non-obsession theme games 1 and 2 month follow-up scores: 69-84% when playing obsession theme games, 71-86% when playing non-obsession theme games Baseline results: 1.7-2.9 Intervention results: 3.5-4.8 Maintenance results: 4.4-4.65 Follow-up results: 3.6-4.7 (A rating of 3.3 to 5 indicates a very positive score, 1.71 to 3.29 indicates neutral affect and 0 to 1.7 shows a negative score)
Charlop-Christy & Haymes (1998)	7-9	2 males 1 female	Mental age 4y 11m, (non-verbal) High-functioning (verbal)	RI as reinforcer in task learning	Cognitive task performance (% correct) Intervals of inappropriate	Baseline scores: 45-60% Intervention scores: 70-90% Baseline results: 3-9% Intervention results: 0-3%

			IQ – 67 (limited verbal skills)		behaviours (%)	
Baker (2000)	5-8	2 males 1 female	Moderate autism	RI incorporated into games played with siblings to encourage social interactions	Intervals engaged in social play (%; mean)	Baseline scores: 16-22% Intervention scores: 87-98% Maintenance scores: 84-93.5% 1 and 3 month follow-up scores: 88-96%
					Occurrence of joint attention behaviours (%; mean)	Baseline scores: 15-21% Intervention scores: 82-97% Maintenance scores: 84-93.5% 1 and 3 month follow-up scores: 87-97.5%
					Child affect (interest and happiness; mean)	Baseline scores: 2-2.46 Intervention scores: 3.55-4.25 Maintenance scores: 3.9-4.2 1 and 3 month follow-up scores: 4-5 (A rating of 3.3 to 5 indicates a very positive score, 1.71 to 3.29 indicates neutral affect and 0 to 1.7 shows a negative score)
					Thematic ritualistic behaviours (% of intervals engaged in; mean)	Baseline scores (non-RI play materials): 9-26% Baseline scores (RI play materials): 25-78% Intervention scores: 2.3-7% Maintenance scores: 0-11% 1 and 3 month follow-up scores: 0 for 2 children and one child engaged in their behaviour once during follow-up

Keeling, Myles, Gagnon, & Simpson (2003)	10	1 female	Scored 100 on a norm-referenced intelligence examination, decoding at 4th grade level, reading comprehension skills at 2nd grade level, social skill deficits (autism severity not specified)	RI incorporated into Power Card Strategy to teach sportsmanship skills	Whining expressions (mean duration in seconds)	*Gross motor game* Baseline result: 18.2s Intervention result: 4.13s *Board game* Baseline result: 6s Intervention result: 0s *Card game* Baseline result: 13.47s Intervention result: 0s
					Screaming expressions (mean duration in seconds)	*Gross motor game* Baseline result: 0s Intervention result: 0s *Board game* Baseline result: 9.5s Intervention result: 0s *Card game* Baseline result 0s Intervention result: 0s
Boyd, Conroy, Mancil, Nakao, & Alter (2007)	5	3 males	2 x mild/moderate autism - limited verbal skills 1 x high-functioning –	RI incorporated into play situations with typical peers to encourage social interaction	Peer-related social interactions (mean % time engaged) Time to child-initiated engagement (mean in seconds)	With non-RI item: 0-12% With RI item: 28-48% With non-RI item: 14-99s (and no initiation from one participant) With RI item: 3-41s

			verbal			
Vismara & Lyons (2007)	3-4	3 males	Nonverbal (severity not specified)	Motivational techniques of Pivotal Response Treatment combined with stimuli relating to RI and tested for increase in initiation of joint attention with caregiver	Joint attention (JA) initiations (per session; approx. mean)	*Children 1 and 2* Baseline results: 0 With RI stimuli: 6-12 With non-RI stimuli: 1-2 Alternating treatment condition first half (RI and non-RI stimuli used): RI stimuli: 5-11, Non-RI stimuli: 1-3 Second half: RI stimuli: 5-11, Non-RI stimuli: 5-7 *No significant differences in the number of JA initiations for RI stimuli in first half of the alternating treatment condition compared to second half. This means the children engaged in just as many JA initiations at start of alternating treatment condition as they did at the end: Child 1- F (1,7) = 0.001, p > .90, Child 2: F (1,7) = 0.005, p > .90* Significant differences were observed in number of JA initiations for non-RI stimuli in second half of alternating treatment condition compared to first. This suggests some generalisation may have occurred, as children were more able to initiate for item not related to RI- Child 1: $F(1,7) = 13.76$, p < .01, Child 2: $F(1,7) = 5.28$, p < .05 <u>Child 3</u> Baseline result: 0 With non-RI stimuli: 0 With RI stimuli: 2 With non-RI stimuli: 0 Alternating treatment condition first half: RI stimuli: 1, Non-RI stimuli: 5 Second half: RI stimuli: 4, Non-RI stimuli: 6

					Measures of Child Affect (approx. mean) 0-1= negative affect 2-3= neutral affect 4-5= positive affect	Significant differences were not observed in the number of JA initiations for RI or non-RI stimuli in first half of alternating treatment condition compared with second: RI stimuli: $F(1,7) = 2.01$, $p > .20$, Non RI stimuli: $F(1,7) = .31$, $p > .60$ *Child 1 and 2* Baseline results: 2-3 With RI stimuli: 4 With non-RI stimuli: 3 Alternating treatment condition first half: RI stimuli: 4, Non-RI stimuli: 3 Second half: RI stimuli: 4, Non-RI stimuli: 3-4 *Child 3* Baseline result: 3 With non-RI stimuli: 3 With RI stimuli: 4 With non-RI stimuli: 1 Alternating treatment condition first and second half: RI and non-RI both 4 *All children showed a trend toward positive affect, but these were not significant.*
Winter-Messiers (2007)	7-21	21 males 3 females	High-functioning (Asperger syndrome)* *After the interviews one student deemed not	Interviews conducted with individuals with autism about their RI and 18 surveys of parents' views obtained	Qualitative data (see Table 1 and Results)	Reported change when engaged with their RI: - improved social self-confidence and control - improved emotional control (focused on interest as way of coping with negative emotions) - improved positive emotions - enhanced communication with animation, emotion, intelligibility, vocabulary and enthusiasm - improved sensory experience (decrease in sensory

			eligible to participate in study as did not have AS diagnosis			challenges) - improved motor skills (enhanced fine motor skills, patience and perseverance)
Mancil & Pearl (2008)	5-18	2 males 1 female	Not specified	RI incorporated into curriculum to encourage improved task performance	Task performance (mainly qualitative data included in results section)	Child 1 – Baseline: 1st grade reading level (for first half of school year) Intervention: 2.5 grade reading level (end of school year), also improved math and science performance (see Results) Child 2 – Improved performance in math, science, English and history (see Results) Child 3 – Improved performance in math, science, English and history (see Results)* *English teacher found it difficult to incorporate this child's RI (electronic gadgets) into lessons
Spencer, Simpson, Day, & Buster (2008)	5	1 male	In a Severe Communication Disorder classroom	RI incorporated into Power Card Strategy to increase playground engagement and social interactions	Time spent on playground with ca. 110 2nd grade students and his 5 SCD peers students (minutes)	Baseline result: 0-1 min Intervention result: 5-10 min Post-intervention result: 9-10 min
Davis, Boon, Cihak, & Fore (2010)	14-18	3 males	High-functioning (Asperger syndrome)	RI incorporated into Power Card Strategy to improve social initiation and conversational skills	Time engaged in others-focused conversation (mean %)	Baseline score: 6.5-24% Intervention score: 29.4-64%
Koegel, Singh, & Koegel (2010)	4-7	3 males 1 female	Not specified	RI and specific motivational variables incorporated into academic tasks	Latency – writing task (time taken to begin the task)	Baseline result: 240-480s Intervention result: 0-60s d= 1.08-2.89 (large effect size)

					Latency – math task (time taken to begin the task)	Baseline result: 20-151.2s Intervention result: 1-6 s $d = 0.75$-1.58 (medium-large effect size)
					Rate of writing task completion (letters per minute)	Baseline score: 0-10.5lpm Intervention score: 14.38-23lpm $d = 2.39$-15.66 (large effect size)
					Rate of math task completion (problems per minute)	Baseline score: 0-1ppm Intervention score: 2-9ppm $d = 3.81$-9.72 (large effect size)
					Disruptive behaviour (number of intervals per session)	Baseline result: 25-100% Intervention result: 0-50% Post-intervention result: 0%
					Interest (level of interest; mean)	Baseline result: 0-1.5 Intervention result: 3.5-5 Post-intervention result: 4-5 (0-1 low interest; 2-3 neutral interest; 4-5 high interest)
Campbell & Tincani (2011)	6	2 males 1 female	1 x high probability of autism 1 x mild autism 1 x mild-moderate autism	RI incorporated into Power Card Strategy in an attempt to improve ability to follow directions	Appropriate direction following (mean % of time)	Baseline result: 35-58% Intervention result: 80-99% Follow-up result: 86-100%

Dunst, Trivette, & Masiello (2011)	2-6	13 males 4 females	Mean developmental age of 44 months (severity not specified)	Explored influence of participation in interest-based learning activities on child development	Developmental quotient	Developmental quotient at baseline: approx. 70 Developmental quotient after intervention when child was in low interest group (meaning they had less opportunities to use their interests): approx. 71 Developmental quotient after intervention when child was in high interest group (meaning they had more opportunities to use their interests): approx. 95
						Cohen's guidelines used to determine effect sizes, d= .20-.45 (small) d= .45-.75 (medium) d= >0.75 (large).
						Linear trend Multivariate result: d= 1.20 Language result: d= 1.36 Cognitive result: d= 1.31 Social result: d= 1.27 Motor result: d= 0.67
						There were statistically significant linear changes in the children's developmental quotients in all linear trend analyses (except motor development).
						Low vs. high interest group Multivariate result: d= 0.12 Language result: d= 0.33 Cognitive result: d= 0.30 Social result: d= 0.28 Motor result: d= 0.18

						Linear increases in the children's developmental quotients were larger in the high interest group than the low interest group. *Linear trend x interest group interaction* Multivariate result: d= 1.25 Language result: d= 0.57 Cognitive result: d= 0.55 Social result: d= 0.47 Motor result: d= 0.30 The sizes of effect for the interactions were medium-large except motor development, which had a small effect size.
Lanou, Hough, & Powell (2011)	School age	4 males	Not specified	RI of children with autism incorporated into curriculum to help them meet challenges in school	Descriptive account of RI inclusion and children's response on: Task performance – Child 1 Meltdown intensity – Child 2 Personal space – Child 3	Child 1 – Improved writing productivity and stamina and began completing tasks along with peers (see Results) Child 2 – Decrease in intensity of meltdowns and improved recovery time (see Results) Child 3 – Decrease in complaints from peers about child invading personal space (see Results) Child 4 – Behaviour improved, more willing to participate in lessons and increased amount and quality of independent work

					Negative behaviours – Child 4	
Koegal, Fredeen, Kim, Danial, Rubinstein, & Koegal (2012)	11-14	3 males	Not specified	RI incorporated into lunch clubs in an attempt to improve engagement with and initiations to typically developing peers	Intervals engaged with typically developing peers (%) Frequency of initiations toward typically developing peers (per session)	Baseline result: 0-3% Intervention result: 85-100% Baseline result: 0 initiations Intervention result: 2.6-16 initiations
Koegal, Vernon, Koegal, Koegal, & Paullin (2012)	9-12	2 males 1 female	All had IQs above 90 (severity not specified)	Interests of children with ASD incorporated into lunch clubs in an attempt to improve engagement with and initiations to peers	Engagement with peers (mean %) Unprompted verbal initiations (per session)	Baseline result: 0% Intervention result: 60-100% 2nd intervention period result (child 1 + 2 only): 100% Baseline result: 0 Intervention result: 1-21
Porter (2012)	5-8 (study lasted 3 years)	1 male	Verbal (severity not specified)	Parent used RI of child with autism to increase his engagement in pretend play	Engagement in pretend play (qualitative data)	Increased engagement with peers and unprompted initiation of verbal engagements (see Results)
Kryzak, Bauer, Jones & Sturmey (2013)	3-14	3 males	Not specified	RI used in an attempt to increase responding to others' joint attention directives	Joint Attention performance (%) *Ratings of RI Intensity* Amount of time engaged in RI	Baseline score: 0-30% Achieved mastery (80%) at 19, 23 and 29 intervention sessions *(High values indicate high RI intensity, scale 1-5)* Before intervention: 3-4

	After intervention: 2-4
Difficulty interrupting or redirecting	Before intervention: 3-5 After intervention: 1-4* *Child 3 increased by one point on the scale
Interference with socialising	Before intervention: 3-4 After intervention: 2-4* *Child 3 increased by one point on the scale
Preference for RI compared with other activities	Before intervention: 4-5 After intervention: 3-5
	(High values indicate better social interaction, scale 1-7)
Ratings of Social Interaction	Before intervention: 1-3 After intervention: 4-7
Child's interest in engaging with interventionist	Before intervention: 2-5 After intervention: 5-7
Child's engagement with interventionist	Before intervention: 1-4 After intervention: 4-7
How communicative child appeared	Before intervention: 3-5 After intervention: 7
How happy child appeared during interaction	Before intervention: 1-4 After intervention: 4-7

How interaction
compared to that of
other peers