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**Social Cognition in Children with Down's Syndrome: Challenges to Research and Theory  
Building**

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**Running Head: SOCIAL COGNITION AND DOWN'S SYNDROME**

**Abstract**

Characterising how socio-cognitive abilities develop has been crucial to understanding the wider development of typically developing children. It is equally central to understanding developmental pathways in children with intellectual disabilities such as Down's syndrome. While the process of acquisition of socio-cognitive abilities in typical development and in autism has received considerable attention, socio-cognitive development in Down's syndrome has received far less scrutiny. Initial work in the 1970s and 80s provided important insights into the emergence of socio-cognitive abilities in the children's early years, and recently there has been a marked revival of interest in this area, with research focusing both on a broader range of abilities and on a wider age range. This annotation reviews some of these more recent findings, identifies outstanding gaps in current understanding, and stresses the importance of the development of theory in advancing research and knowledge in this field. Barriers to theory building are discussed and the potential utility of adopting a transactional approach to theory building illustrated with reference to a model of early socio-cognitive development in Down's syndrome. The need for a more extensive model of social cognition is emphasised, as is the need for larger-scale, finer-grained, longitudinal work which recognises the within-individual and within-group variability which characterises this population. The value of drawing on new technologies and of adapting innovative research paradigms from other areas of typical and atypical child psychology is also highlighted.

Keywords: behavioural phenotype, developmental theory, Down's syndrome, social cognition

## **Introduction**

Definitions of intellectual disability change from decade to decade as research refines our understanding of the challenges faced by those with significant levels of cognitive impairment. Alongside recognition of core cognitive difficulties, most definitions of intellectual disability, past and present, refer to associated difficulties in social adaptation. This wide-ranging term covers both social coping and self-help skills, as well as more complex perceptual and interpretative socio-cognitive processes.

In the field of intellectual disabilities, there has been a perhaps understandable tendency for researchers to focus more on studying children's immediate social needs than on exploring the socio-cognitive processes that underpin social behaviours and drive more complex forms of social learning. With the exception of the study of autism and Williams syndrome, there has in fact been relatively little research into socio-cognitive development in children with intellectual disabilities. This may be in part because of the clinical, life-skills focus of much research, but also perhaps because social cognition is seen as the softer sister of 'pure' cognition and not therefore the primary source of the everyday difficulties experienced by those with intellectual disabilities.

In the case of Down's syndrome, an additional factor contributing to this paucity of research may be the stereotypical perception that children with Down's syndrome are highly sociable and have good 'people' skills (Down 1866; Rogers 1987; Wishart & Johnston 1990; Hines & Bennett 1996; Wishart & Manning 1996; Gilmore et al. 2003; Fidler et al. 2008). This has led to a widely-held assumption that their social understanding is relatively intact. This lack of research seems unfortunate, as social processes are now widely acknowledged as a major

driver of cognitive development in typically developing children (see e.g. Flavell 1999; Flavell et al. 2002; Hobson 2002; Carpendale & Lewis 2006; Zlatev et al. 2008) and there seems little reason to assume that these social processes play any less of a role in the overall development of children with Down's syndrome (for review, see Cebula & Wishart 2008). Indeed, one key theoretical challenge for this field is to reconcile the seemingly outgoing nature of children with Down's syndrome with their poor rate of cognitive development and the apparent decline in this as they grow older (Dunst 1990; Hodapp & Zigler 1990; Wishart & Duffy 1990; Carr 1995; Hodapp et al. 1999).

Although social cognition in Down's syndrome has been rather neglected in recent decades, a growing number of researchers are now beginning to focus their attention on this core area of development. Building on the early work of Zigler and his colleagues (e.g. Zigler 1969; Zigler & Hodapp 1986), recent studies have taken a developmental approach to teasing out where the socio-cognitive challenges lie for children with Down's syndrome. Rather than focusing on just differences or deficits in developmental processes, researchers have also looked through the 'lens' of typical development at the whole child and at the environment in which they grow and learn (Burack 2008). This has been complimented by the parallel trend of contrasting the development and developmental pathways of children with intellectual disabilities of differing aetiologies in the context of behavioural phenotype theory, an approach which involves the identification of distinct profiles of development associated with specific genetic syndromes (e.g. Dykens 1995; Dykens et al. 2000; Fidler 2005; Oliver & Woodcock 2008).

For the purposes of this annotation, social cognition is broadly defined as the ability to make sense of other people (Kunda 1999) and includes the ability to plan and execute appropriate

ways of responding in everyday social contexts. Within the wide-ranging hierarchy of relevant abilities, there is a need to distinguish lower-level (though still essential) perceptually-driven processes from more complex cognitively-driven abilities (see e.g. Tager-Flusberg & Sullivan 2000). In typical development, the core processes involved are first evidenced very early in life, primarily in episodes of emotional engagement with others, and subsequently in increasingly complex interpersonal interactions, with the latter supported by rapidly growing communicative and language skills. The earlier aspects of social understanding are sometimes referred to as social-perceptual abilities. Later, children develop a more interpretive understanding - a "theory" that other people have intentions, thoughts, beliefs and emotions, and that these influence their behaviour and how they interact with others (see e.g. Carpendale & Lewis 2006; Chiat & Roy 2008; Reddy 2008). Because these later developing skills may require some level of interpretation, they are often termed socio-cognitive abilities.

This annotation begins with a brief synopsis of key issues in the understanding of socio-cognitive development and then goes on to look at findings from studies of social cognition in children with Down's syndrome. Our aim is to provide an overview of the current literature on the development of social cognition in Down's syndrome and to relate this to current knowledge of typical development. We also begin to identify developmental pathways that may be unique to Down syndrome, and highlight areas in which critical data are missing. Along with outlining some of the practical and conceptual obstacles which face researchers in this field, we consider the challenges the field faces in developing theories of social cognition relating to this specific child population and in applying them to develop tailored interventions.

### **Key issues in social cognition**

In typical infants, studies of social cognition have focused mainly on joint attention, imitation, and social referencing, and on the importance of caregiver interaction and the development of attachments (see e.g. Rochat & Striano 1999; Bornstein & LeMonda 2001; Eckerman & Peterman 2001; Lock 2001; Meltzoff 2007). In pre-school children, the focus has been predominantly on the emergence of pro-social behaviours, theory of mind and moral understanding, and in older children, on the nature of peer relations, the origins of antisocial behaviours, and the developing cognitive complexity associated with these areas of functioning.

Work in the last twenty years has greatly clarified the nature of early socio-cognitive capacities and has catalogued the sequence of their emergence in typically developing infants. However, there is still no consensus about how this understanding emerges (see e.g. Hobson 2002; Carpendale & Lewis 2004; Reddy 2008). There are ongoing debates about the relationships between and the relative importance of each aspect of functioning, about whether some aspects of social cognition are domain specific or not (Saxe & Powell 2006; Stone & Gerrans 2006; Leekham et al. 2008), and about the nature of the transactions between genes, brain, behaviour, cognition, and the environment (Karmiloff-Smith, 2006, 2007, 2009). Understanding social cognition requires integrated models of social development that consider all levels of explanation, from molecular genetics to the role of parenting. However, individual fields have become highly specialised and there has been limited progress in developing an over-arching theory of socio-cognitive development, largely, we suspect, because of the rapidity with which new data are emerging in each of these distinct fields of investigation.

One highly theoretical yet somewhat insular area of research in social cognition in recent

years has been in the area of “theory of mind”. This focuses on children's developing understanding of the mental states of others, and on how they use this information to predict and relate to the behaviour of adults and other children in social contexts (Wellman 1990). There is considerable debate about the developmental sequelae of a “theory of mind”, with arguments about the relative importance of perceptual processes and cognitive capacities such as executive functioning and about the role of joint attention, empathy, emotion recognition, and imitative capacities (see e.g. Carpendale & Lewis 2004; Bull et al. 2008). These debates have been invigorated by findings from the field of social-neuroscience. For example, recent work has discovered mirror neurons, which respond to the intended actions of others at a sub-threshold level and may give access to the minds of others through simulation of their emotions and intentions (Iacoboni & Dapretto 2006, but see Gallagher 2007 for a critique). Understanding of the role that joint attention and emotional patterning may play in the development of theory of mind, and in underpinning our abilities to “identify” with others, is also still being developed (see e.g. Hobson & Hobson 2007; Tomasello et al. 2007).

These ongoing debates over theory of mind have been closely linked with attempts to understand the nature of autism and have consequently focussed specifically on those aspects of social functioning with which children with autism have difficulties. While this approach has been fruitful, and has yielded many important new theoretical perspectives on both autism and typical development, the focus on autism may mean we have been underestimating the significance of aspects of behaviour that may lead to differences in social cognition in children with other intellectual disabilities. The detailed study of syndrome-specific developmental trajectories may reveal small differences in early behaviour that are not the primary source of



social difficulties for children with autism, but which could nevertheless lead to unique developmental pathways. In the case of Down's syndrome, the children have often been involved in social cognition studies only as control participants, the implicit assumption being that apart from being cognitively delayed they are otherwise socially typical. As we will highlight below, this assumption may be false and there may be some areas of social cognition in which children with Down's syndrome exhibit unique patterns of behaviour. A better understanding of these differences in Down's syndrome and in other distinctive syndromes is essential to building more complete theories of typical and atypical development (Karmiloff-Smith et al. 2004; Karmiloff-Smith 2006, 2007, 2009).

### **Social cognition in children with Down's syndrome**

Much of the early research on the social abilities of children with Down's syndrome was undertaken in the 1970s and 80s. This tended to focus on infants and toddlers, studying the precursors of socio-cognitive abilities which emerge in later childhood and beyond. In many respects, development at these early stages was found to be very similar to typical development in terms of the sequence in which early abilities unfolded (for overview, see Cicchetti & Beeghly 1990). However, there was also evidence of subtle differences in how children with Down's syndrome attend to the social world around them, differences which might well impact on the development of later, more complex, socio-cognitive abilities such as emotion recognition, theory of mind and empathy. Differences in these early interpersonal responses may also influence language development, which in turn plays a central role in the development of successful interpersonal functioning at later ages.

One example of differences in social attention seen at the very earliest stages of development is in mutual gaze with caregivers (looking into each other's eyes). This is initially slow to emerge in children with Down's syndrome, although by later in the first year, as typically developing infants focus on the wider social and physical world around them and mutual gaze begins to decline, it continues to be maintained at high levels (Berger & Cunningham 1981; Carvajal & Iglesias 2000). This heightened attention to people may be indicative of a higher level of inherent sociability (Ruskin et al. 1994), but it could also be an indication of a poorer ability to switch attention efficiently between people, objects and the environment.

Work by Legerstee and Weintraub (1997) indicates that although infants with Down's syndrome do develop joint attention (directing their gaze in the direction that others are looking or pointing), their acquisition of this important ability is slower than in typically developing children of a similar developmental age. Even when infants are able to initiate joint attention episodes, they tend to spend more time as passive participants, sharing attention to objects with adults rather than coordinating attention by actively pointing to objects themselves. These differences may become more apparent with age. Legerstee and Fisher (2008), for example, report that differences in joint attention between infants with Down's syndrome and typically developing infants, while not apparent at a mental age of 9 months, were more evident by 18 months. Kasari et al. (1995), however, have reported similar frequencies of joint attention in young children with Down's syndrome in comparison to typically developing children, and it may be that differences arise only in specific contexts, such as those with a high cognitive load (see also Hobson et al. 2009).

From the latter half of the first year onwards, typically developing infants gradually

develop the ability to use nonverbal gestures such as pointing and requesting. These support the child's acquisition of language and open up a world of possibilities for learning about objects and people in the surrounding environment. In general, it has been found that young children with Down's syndrome use pointing and requesting gestures competently to communicate with others. However, there are again some subtle differences, particularly in the use of requesting gestures, with the children making fewer such spontaneous gestures than their mental-age matched peers (Mundy et al. 1988; Franco & Wishart 1995; Fidler et al. 2005). Again, context proves to be important, with this diminished use of requesting behaviours less pronounced in social than in toy-play situations (Fidler et al. 2005). Work by Adamson et al. (2009) comparing children with Down's syndrome, autism and typically developing children of similar language ability found that the children with Down's syndrome were more likely to be unengaged during contexts designed to encourage requesting or commenting than during contexts designed to encourage simple interaction, a difference not seen in typically developing children (not surprisingly perhaps, the children with autism showed significantly less engagement across all contexts). The authors interpret this as indicative not only of differences in willingness to become engaged in specific kinds of interpersonal interactions, but also as evidence of how different disorders impact differently within different social contexts. They also drew attention to specific differences in 'symbol-laden' (i.e. language-based) joint attention, which they suggest may be particularly problematic for children with Down's syndrome.

The imitation of others is widely recognised as a behaviour which is crucial to learning in the early years. The ability to imitate is evident very soon after birth in typically developing infants (Meltzoff & Moore 1977, 1989) and underpins both the development of relationships with

others and socially-based learning. Down himself (1866) drew attention to the ability of children with Down's syndrome to imitate others, and indeed a number of studies suggest that this may be a relative strength, something which fits with evidence of the children being, at times, more socially orientated than their typically developing peers (Neeman 1971; Pueschel et al. 1987; Hodapp et al. 1992; Rast & Meltzoff 1995). However, while there is some evidence for intact neonatal imitation in newborns with Down's syndrome (Heimann et al. 1998), there is also evidence from a large-scale longitudinal study of marked differences in the growth of vocal imitation over the first three years of life, with a clear slowing down in the acquisition of key stages with increasing age (Dunst, 1990). Work by Wright et al. (2006) likewise suggests that there may be important differences in how imitation is used by toddlers with Down's syndrome, with imitative strategies applied to solve cognitive tasks in situations where more independent, cognitively-driven strategies, as used by typical children of comparable cognitive level, would be more appropriate and more successful. The authors suggest that this imitative 'bias' may result from a predisposition to attend to social, rather than non-social, aspects of the world.

Another important socio-cognitive tool for interacting and learning from others is social referencing, the ability to use emotional cues from others in interpreting shared contexts. Social referencing studies with young children focus on the extent to which they use their parent's affective reaction to a situation to guide their own response. Findings indicate that children with Down's syndrome may make fewer and shorter social referencing looks than typically developing children, with their own responses often incongruent with the parent's affective reaction (Knieps et al. 1994; Kasari et al. 1995). This suggests that even in the early years, children with Down's syndrome may have difficulties in emotion recognition and/or in making

use of this information to guide their own behaviour.

These early developing capacities for joint attention, non-verbal requesting, imitation and social referencing underpin children's ongoing relationships with people and their interactions with objects in their environment. In typical development, these early capacities lead on to the development of increasingly complex socio-cognitive abilities, such as understanding emotions and theory of mind.

Studies with school-aged children with Down's syndrome suggest that the difficulties with emotion recognition found in social referencing studies might continue into later years. Tasks using photo-matching or puppet paradigms to explore emotion recognition have shown that in comparison to typically developing children of a similar level of cognitive ability, some children with Down's syndrome may experience difficulties in recognising some of the core facial expressions of emotion. Difficulties have been found in particular with the recognition of fear, surprise and anger (Wishart & Pitcairn 2000; Kasari et al. 2001; Williams et al. 2005; Wishart et al. 2007), with similar findings recently reported in a study with adults (Hippolyte et al. 2008). To date, the difficulties found have been relatively subtle and the evidence for a syndrome-specific profile of emotion recognition difficulties is not yet strong, as comparisons with children with other aetiologies such as non-specific intellectual disability or fragile X syndrome have found few significant between-group differences (Turk & Cornish 1998; Wishart et al. 2007). Nevertheless, across a number of these studies, in comparison to closely-matched groups of typically developing children, evidence has been found for some differences in this important aspect of social understanding.

Research into other areas of social cognition, such as theory of mind, similarly suggest that

children with Down's syndrome may experience difficulties in this domain, but with these difficulties being less obvious and more subtle than those found in children with autism (Yirmiya et al. 1996; Zelazo et al. 1996; Abbeduto et al. 2001; Binnie & Williams 2002). Studies of empathic responses also reveal some differences, with children with Down's syndrome not only showing equivalent, or higher, levels of pro-social empathetic behaviours than typically developing children of similar cognitive and linguistic ability in situations where an adult is affecting distress, but also showing lower levels of affective responses themselves (Kasari et al. 2003). A relative dampening of affective responses, in particular a tendency not to show distress, has for some time been suggested as a core feature of infants with Down's syndrome (Emde et al. 1978).

Overall then, studies to date suggest that while it may appear that socio-cognitive development in Down's syndrome unfolds in a similar fashion to that seen in typical development, albeit at a slower rate, there are also some important qualitative differences. Despite the common assumption that children with Down's syndrome have a predisposition for being sociable, there is evidence from a wide variety of studies of subtle differences across a range of socio-cognitive abilities, from early infancy onwards. These differences occur in combination with difficulties in developing efficient task-orientated strategies in problem-solving tasks (Wishart, 1993, 1996; Pitcairn & Wishart 1994; Kasari & Freeman 2001; Jahromi et al. 2008), difficulties with goal-directed persistent behaviour (mastery motivation) on challenging tasks for infants and toddlers (Glenn et al. 2001, but see also Gilmore et al.'s (2003) contrasting results at slightly older ages), and lower levels of mastery motivation as measured by parental ratings from infancy through to the early school years (Ruskin et al. 1994; Glenn et al. 2001;

Gilmore et al. 2003). Taken together, these differences may account, at least partially, for differences seen in interactions with peers and adults in both social and educational contexts (e.g. Wishart et al. 2007). They must also undoubtedly add to problems in developing interpersonal relationships throughout life, and may ultimately impact on quality of life and mental health in adulthood.

There are still many gaps in our knowledge of social cognition in Down's syndrome and explanations for socio-cognitive difficulties at the neurological, cognitive, and environmental level all need to be considered. Unravelling these different contributory factors presents a considerable challenge. At the neurological level, there is evidence of both structural and processing differences in Down's syndrome which may be tied to the socio-cognitive difficulties evidenced at different stages in the children's development. For example, some areas of the temporal limbic system – an area crucial for the processing of emotions – have been found to be disproportionately reduced in volume and complexity in Down's syndrome, although this seems to relate more to the hippocampus than to the amygdala (Alyward et al. 1999; Pinter et al. 2001; Jernigan et al. 2002). The frontal cortex is also disproportionately reduced in volume (Jernigan et al. 1993) and during visual recognition tasks there is evidence of differences between typically developing infants and those with Down's syndrome in frontal and parietal site brain activity (Karrer et al. 1998). Knowledge of any underlying neuropathology and of differences in neurological processing in children with Down's syndrome is still remarkably limited, but differences such as these may well be implicated in the difficulties seen in socio-cognitive development.

Neurological differences have also been linked to cognitive development more broadly in

Down's syndrome. For example, there is some evidence that children and adults with Down's syndrome experience difficulties with some 'executive functions' – goal-directed behaviours which are linked to the development of frontal areas of the brain (Zelazo & Stack 1997; Karrer et al. 1998). For example, difficulties with set shifting, verbal short-term memory, and dual-task processing have all been reported (Zelazo et al. 1996; Jarrold & Baddeley 1997; Jarrold et al. 2000; Brock & Jarrold 2005; Rowe et al. 2006; Kittler et al. 2008). If these difficulties are present at younger ages, they may contribute to problems with aspects of early socio-cognitive development such as joint attention. Additional difficulties with expressive language and syntactic development which emerge in the preschool years (Fowler 1990; Miller 1999; Chapman 2003; Roberts et al. 2007), as well as long-term memory difficulties (Pennington et al. 2003), may further contribute to problems with the development of subsequent, more complex socio-cognitive abilities.

It must also be recognised that this profile of social and cognitive strengths and weaknesses will shape the children's social environment and change the landscape of their social interactions with children and adults, at home and at school. From the first year onwards, differences in caregiver interactions and parenting style can be observed, with caregivers adjusting their style of interaction in a number of ways to adapt to their children (Slomins & McConachie 2006). For example, while there are similarities between mothers of toddlers with Down's syndrome and mothers of typically developing toddlers in play situations (e.g. both become attuned to the child's level of play and contribute to the child's play development), there are also clear differences, with maternal interaction leading to increases in exploratory play in toddlers with Down's syndrome but to increases in sophisticated symbolic play in typically developing toddlers



(Venuti et al., 2009). Mothers may develop means of adapting to meet their child's specific developmental needs. Studies have also reported, for example, that mothers of young children with Down's syndrome provide more supportive behaviours than mothers of other children and may take more opportunities to stimulate their child during play, a style of interaction characterised as "directive but warm" (Buckhalt et al. 1978; Sorce & Emde 1982; Cielinski et al., 1995; Roach et al. 1998; Moore et al. 2008). These patterns of interaction may be a positive response to limitations in the infant's attention regulation and information-processing capacity, although as Moore et al. (2002, 2008) point out, the longer-term developmental implications of these interactive styles may not necessarily be positive if they interfere with the infant's own development of a sense of agency. As noted by Moore et al., further longitudinal studies are required to explore the long-term impact of maternal interaction style. Any such work should consider other variables, including parent demographic factors, stress levels, cognitive coping strategies, and perceptions of their child's behavioural characteristics, as these all have the potential to influence mother-child interaction (see e.g., Atkinson et al., 1995; Kasari & Sigman, 1997). It is of note here that although mothers of children with Down's syndrome have in the past been considered to have relatively low levels of stress, compared to mothers of children with other developmental disabilities, in fact this 'Down's syndrome advantage' may be less substantial than often assumed, and partly explained by maternal age and child adaptive behaviour levels (Corrice & Glidden, 2009). The potential influence of culture on maternal interactive style must also be considered. For example, the often reported higher level of directiveness has not been found in Italian mothers of toddlers with Down's syndrome (Venuti et al. 2009) something which the authors suggest may relate to cross-cultural differences in

maternal levels of sensitivity and sociability towards their children. Maternal interactive style is also likely to be highly variable. For example, Venuti et al. (2008) report marked individual differences in sensitivity levels in mothers of children with Down's syndrome, something which contributed to differential effects on their children's symbolic play.

Differences in mothers' interaction styles continue as the child develops. Kasari et al. (2001), for example, note evidence from Tingley et al. (1994) that mothers of 3-8 year old children with Down's syndrome use fewer emotional and cognitive state terms in meal-time conversations with their children than mothers of typically developing children do. Again, although this adjustment may be to better meet the ability level of their child, it has been suggested that it could also contribute to later socio-cognitive difficulties, in areas such as emotion recognition (Kasari et al. 2001). There is growing evidence from studies of young, typically developing children that maternal talk about mental states provides a "stepping stone to others' minds" (Taumoepeau & Ruffman 2008), predicting children's own use of mental state language, theory of mind ability and emotional understanding (Meins et al. 2002; Taumoepeau & Ruffman 2006, 2008; Ensor & Hughes 2008). There is no reason to assume that this would not also be the case in Down's syndrome, but as yet this developmental pathway has not been explored.

To date, with few exceptions (e.g. Knott et al. 1995, 2007; de Falco et al. 2008), studies in this field have focused primarily on early mother-child interactions and rather less is known about how interactions with fathers, siblings and peers shape developing socio-cognitive abilities at either younger or older ages. This is an area ripe for investigation. In relation to father-child interactions, it is not currently clear whether fathers adopt the same 'directive but warm' style

shown by mothers, although very recent research on emotional availability suggests there are no differences in terms of sensitivity, structuring of interactions, or intrusiveness nor are there significant differences in child responsiveness in the early years (de Falco et al. 2009). Positive paternal influences on the play of preschool children with Down's syndrome have also been reported (de Falco et al., 2008), with children showing more symbolic play in sessions with their fathers than in solitary sessions, particularly when fathers displayed a high degree of emotional availability. However, there appears to have been no research on father-child interactions at older ages and none directly comparing the extent to which fathers of children with Down's syndrome may differ from fathers of typically developing children in their interactive style.

It has long been argued that sibling relationships are critically important to the acquisition of social abilities in childhood (Dunn, 1988), and many siblings play a major role in the social life of the child with Down's syndrome. While there has been some detailed family research on the effects on siblings of having a brother or sister with Down's syndrome (e.g. Cuskelly & Gunn, 1993, 2003, 2006; van Riper, 2000), there have been few investigations of the actual nature of sibling interactions at different ages and at different developmental stages.

Amramovitch, Stanhope, Pepler & Corter (1987) studied sibling interactions and reported that, irrespective of birth order or gender, the child with Down syndrome tended to adopt the role of the 'younger' sibling, imitating the actions of their typically developing brother or sister and following their lead rather than initiating activities themselves. Similarly, Stoneman et al. (1987) and Knott et al. (2007) have reported strong role asymmetries in observed interactions, with siblings often taking on a 'teacher' role. Although Knott reported some increase in frequency of initiation of pro-social interactions by the children with Down's syndrome over a one-year

period, this proved to be largely the result of the typically developing siblings "stage-managing" the interactions. This sibling interactive style shows some parallels with the warm directive style reported as characteristic of mothers of infants with Down's syndrome, and again, although well-motivated and possibly productive in the short-term, the longer-term effects of this strategy on the development of the children's socio-cognitive understanding and on their future expectations of social partners are unclear.

While it seems likely that some of the differences in socio-cognitive development described in this paper would also impact on, and be influenced by, peers, most research on peer interactions in children with intellectual disabilities has focused on heterogeneous groups. As such, little is known specifically about peer interactions in children with Down's syndrome. Studies do suggest some similarities with developmentally-matched children in terms of the characteristics of the children's involvement with peers, such as number of regular playmates and frequency of contact with peers (Guralnick, 2002; Guralnick, Connor & Johnson, 2009a, 2009b), although it is notable that some mothers of 4-7 year olds with Down's syndrome in the Guralnick et al. studies could not identify a single regular, out-of-school playmate for their child. In addition, while many children with Down's syndrome in their early school years may meet the criteria for having a reciprocal friendship, unlike typically developing children, these relationships may not be with children of a similar developmental level, leading to concerns over their long-term stability (Freeman & Kasari, 2002). Moreover, as Guralnick and his colleagues note, it is often parents and teachers, rather than the children themselves, who initiate, structure and support these peer interactions and friendships.

Despite a widespread perception that sociability is a relative strength in children with

Down's syndrome, the teachers in Guralnick et al.'s study (2009b) in fact rated the children as being less prosocial and more asocial than either their age- or stage-matched typically-developing peers and as needing the greatest amount of assistance in getting play started, remaining involved, understanding social rules, and knowing how to play with others. They were also rated as more distractible and hyperactive and as having higher levels of behavioural problems than their typically developing matches, all characteristics likely to be disruptive to peer interactions within the classroom.

Given the emphasis on improving educational attainment in recent decades, it is perhaps remarkable how little research there has been examining the nature and outcomes of peer interactions within the classroom for the child with Down's syndrome. One recent exception is a study which looked at collaborative problem-solving in three performance-matched child groups: typically developing children, children with non-specific intellectual disability and children with Down's syndrome (Wishart et al. 2007). On the basis of individual pre-test performance on a shape sorting task, collaborative pairs were formed in which one partner was slightly more able at sorting than the other, although this was not made explicit to the children. Following the collaborative session (working jointly on a furniture sorting task), individual post-test shape sorting scores indicated significant improvement in lower ability partners in the typically developing pairs and in higher ability partners in the pairings made up of two children with non-specific intellectual disability. Neither partner improved significantly in pairings in which one partner had Down's syndrome and the other non-specific intellectual disability, however, suggesting that the sociability attributed to children with Down's syndrome did not necessarily support either their or their partner's learning in this particular socio-cognitive context.

Interactions were in fact characterised by low levels of both social and task-related communication, with the 'partners' sometimes simply working in parallel on the set task. Collaborative interaction was also noticeably more limited and was less frequently initiated by the partner with Down's syndrome.

Findings such as these have led some researchers to express concern that inclusive education policies may be based on an underestimation of the educational and socio-cognitive difficulties which many children with Down syndrome experience at school as the developmental gap between them and their chronological age peers widens (Wishart, 2005). Other researchers have emphasised the need for intervention strategies at all ages to better recognise the aetiology-specific nature of some of the difficulties which may arise (e.g. Dykens et al. 2000; Dykens & Hodapp 2001; Fidler & Nadel 2007).

The extent to which difficulties in socio-cognitive development impact on peer interactions at later ages is clearly not yet well-researched but there is good evidence that by adolescence, many children with Down's syndrome experience loneliness, even in school and community settings intended to be inclusive (see e.g. D'Haem 2008). Only a minority of children experience true sustained friendships, some have imaginary friends well into adolescence, and a good number often prefer their own company to that of others (Buckley & Sachs 1987; Byrne et al. 1988; Sloper et al. 1990; Carr 1995; Dykens & Kasari 1997; Cuckle & Wilson 2002). As young people with intellectual disabilities are twice as likely as other young people to develop mental health problems (Mental Health Foundation 2002), this pattern of increasing social isolation is of considerable concern.

The significant speech and language difficulties which accompany the cognitive

impairments associated with Down's syndrome (for overviews, see Fowler 1990; Chapman 2003; Martin et al. 2009; Timmins et al. 2009) can only exacerbate the children's interpersonal difficulties. In a large survey of parents of children with Down's syndrome, over 95% reported that individuals immediately outside the family experienced difficulties in understanding their child's speech (Kumin 1994, see also Buckley & Sacks 1987). These intelligibility problems are rarely targeted in traditional speech and language therapy although encouraging results have recently been reported from interventions using high-tech, computer-based approaches to correct speech patterns in children and adolescents with Down's syndrome (Wood et al. 2009).

A better understanding of the causes and developmental profiles of the socio-cognitive difficulties described above is essential if appropriately-targeted and effective interventions are to be developed. As with research into many key areas of functioning in those with intellectual disabilities (Hatton et al. 1999), social cognition in Down's syndrome has to date been surprisingly neglected, even within intellectual disability research itself. The range of ways in which neurological, cognitive and environmental factors all contribute to the development of the abilities necessary for successful interpersonal interactions is still by no means clear in typical development, but it is even less so in Down's syndrome. The extent to which the adoption of a more theoretical approach would move this field forward is therefore an important consideration.

### **Developing theoretical frameworks**

It is clear that although recent years have seen a gradual increase in knowledge of some important aspects of social cognition in children with Down's syndrome, the overall picture remains very incomplete, particularly with respect to development beyond infancy and the

preschool years. It is also clear that this is a field in which theory has played a less prominent role than it has in other areas of typical and atypical development. Would a more theoretical focus be beneficial, and if so, in what ways? One area to explore is whether a more theoretical focus would lead to an improved conceptualisation of the socio-cognitive profile associated with Down's syndrome. The second is whether it would lead to more appropriately-targeted and more successful ways of supporting development in children with Down's syndrome in interventions and in educational settings.

In relation to the first point, it is worth noting that in both typical and atypical development some areas of research have moved forward very rapidly following advances in theory building. A particularly clear example of this was the impact that theories of "theory of mind" had on autism research (see e.g. Baron-Cohen et al. 2000). While these theories had limitations, they led to clear, specific and testable predictions, and were undoubtedly partially responsible for the growth of interest in social cognition in children with autism. Other factors also contributed to this growth, however, including the design of research tasks that could be easily and widely used (e.g. the unexpected transfer task, Wimmer & Perner 1983). It also benefited from the concurrent development of innovative technologies (e.g. fMRI and eye-tracking) and from the availability of substantial funding specifically for research into autism.

A more theoretical focus might, then, lead to more detailed knowledge and a deeper understanding of the socio-cognitive profile associated with Down's syndrome. This alone may not be sufficient to stimulate and drive research in this area, however. Some agreement on core paradigms and protocols is clearly needed, as is a much greater investment in research into intellectual disabilities in general, and into Down's syndrome in particular (Morris 2008;



Rasmussen et al. 2008).

Whether a more theoretical focus would ultimately lead to more successful interventions is perhaps even less certain. At present, findings from socio-cognitive research in Down's syndrome are not sufficiently detailed to be translated into effective interventions. For example, although there is some evidence, as discussed above, that children with Down's syndrome may experience difficulties in emotion recognition, knowing how best to intervene to support development in this area is far from obvious. It is not yet clear, for instance, why some children experience greater difficulties in recognising emotions than others, precisely what role is played by levels of language, memory and cognitive ability in emotion recognition, or how early interactions with peers and caregivers may support or hinder development of this aspect of socio-cognitive functioning.

Interventions for children with Down's syndrome have moved away from being solely child-centred and focusing on purely cognitive abilities, and now recognise both the importance of social cognition and the central role that the child's early interactions with others play in development (e.g. Iarocci et al. 2006). However, the most appropriate ways to support socio-cognitive development in children with Down's syndrome at different stages in their development have still to be identified. Interventions which focus on developing socio-cognitive and social adaptive skills have important potential consequences for social inclusion and quality of life, and must take into account the child's family, peer and community context (Guralnick 2006; Iarocci et al. 2008). Without more detailed knowledge of how social cognition develops throughout the childhood years in Down's syndrome, this will be difficult to fully achieve.

Numerous parent-directed and child-led interventions are currently available for children on the

autism spectrum, but it is not clear which, if any, of these approaches could be adapted for use with children with Down's syndrome. While the findings discussed earlier of mothers' 'directive but warm' interactive style suggest that a parent-directed intervention, such as Applied Behavior Analysis (see e.g. Lovaas 1987), might be a suitable strategy, there is no research evidence available to support this. A more child-led approach, which encourages the child to take the lead in ongoing social interactions (e.g. Intensive Interaction; Nind & Hewett 1994), might also be appropriate, given the evidence that children with Down's syndrome may be more passive partners in interactions. Without evaluation studies, and further more detailed knowledge of socio-cognitive development, it will remain difficult to identify the intervention routes which are most appropriate for children with Down's syndrome and their families.

These challenges in mapping theory to intervention are by no means unique to research into Down's syndrome. Even in relation to autism, some of the most influential theories, like theory of mind, have not yet been successfully translated into interventions that have led to significant and generalisable gains in socio-cognitive abilities. As a result, many practitioners continue to base their intervention methods on prior clinical experience and professional opinion, rather than on theoretically-driven scientific findings (Jones & Jordan 2008).

Despite some difficulties in translating theory into practice, it seems unlikely that the development of a more theoretical approach to socio-cognitive development in Down's syndrome, as in autism, would not be of benefit to the field. We need, though, to consider why attempts to do so have been so limited to date. One obvious barrier to theory building is the fact that, to date, the majority of research involving children with Down's syndrome has focused on providing increasingly detailed behavioural descriptions, rather than on testing competing

theoretical accounts. This is in sharp contrast to the fields of autism and typical development, where there is now a large body of socio-cognitive research which tests findings against differing theories. For example, there has been considerable study of the development of an understanding of intended actions, of the development of meta-representations and theory of mind, and of the relationship between cognitive processing capacities and social abilities (see e.g. Hughes & Leekham 2004; Tomasello et al. 2005; Beeger et al. 2008). All of these areas have been under-researched in children with Down's syndrome. This difference may be due to a number of inherent barriers to developmental research into Down's syndrome which need to be acknowledged and which may explain both the major gaps in our knowledge of the sequence and nature of socio-cognitive development in Down's syndrome, and also the lack of any significant advances in theory-building in this area. A strategic attempt to fill these knowledge gaps is urgently required, along with a drive towards developing studies that are aimed at testing competing theoretical accounts rather than simply providing behavioural descriptions.

A further barrier to theory-building in Down's syndrome has been the relative lack of links made between behavioural research and the fields of genetics and neurosciences. For these links to be made, we need to develop far better psychological accounts of individual differences in ability profiles across children with Down's syndrome and of cross-group overlap in strengths and deficits in Down's syndrome and in other intellectual disabilities with differing aetiologies (such as fragile X syndrome and Williams syndrome, see e.g. Kogan et al. 2009; see also Pennington, 2009). Children with Down's syndrome show considerable variation in levels of socio-cognitive competence, but despite this, behavioural studies often treat groups of children with Down's syndrome as homogeneous; likewise, genetic and neurobiological studies often use

incomplete models of the Down's syndrome social behavioural phenotype when trying to relate genes to behaviour (Chapman & Hesketh, 2000).

Bridging this gap will not be an easy task. Involving sufficiently large numbers of participants with Down's syndrome across the necessary age ranges to allow studies to have the statistical power to identify and track key developmental changes - particularly when these may be very subtle and detectable only in some cross-group comparisons - has always been a major problem for Down's syndrome researchers. For real advances to be made, large-scale, multi-site, collaborative studies, using shared agreed protocols are sorely needed. Finding funding for such national or international studies is not likely to be easy, however.

A final barrier to theory development has been the lack of a good framework for the representation of theoretical models across all of the many disciplines involved in Down's syndrome research, one which would enable causal theoretical accounts of social cognition in Down's syndrome to be constructed. At present there are few accounts of Down's syndrome that attempt to make links between molecular genetics, neuroscience, cognitive processes and social behavioural outcomes, or which attempt to develop integrated overarching theories. Complete causal theories of socio-cognitive development require a full understanding of the long-term sequence of behavioural development and must explain not only group characteristics, but also how individual differences within the population emerge through transactions between all levels of explanation. Morton (2004) has gone some way to developing a universal means of notating causal, developmental relationships that incorporate all levels of explanation in theories. While this approach needs additional refinement if extended to Down's syndrome, it has been usefully applied in the field of autism, fragile X and Williams syndrome and could similarly be applied to

explanations of Down's syndrome, perhaps helping in clarifying competing theoretical positions in the future.

It is clear from the preceding discussion that the development of children with Down's syndrome is likely to be influenced by a great many factors other than the inherent constraints that Down's syndrome itself places on cognitive development. For socio-cognitive development in particular, the opportunities and support provided by the child's family and wider social and educational networks are likely to be critical in driving development. It is also clear, though, that despite the potential benefits of theory building in this field, the development of an over-arching theory of social cognition in Down's syndrome is still some considerable way off.

In typical development transactional theories of development are now dominant. Such theories attempt to describe the nature, extent and direction of influence of different areas of psychological functioning on each other and the bidirectional nature of the relationship between children and their environment. It might, therefore, be profitable to explore the extent to which a transactional approach might be helpful in understanding and extending knowledge of the pattern of social cognitive strengths and weaknesses found in Down's syndrome.

Although there is, as yet, no established transactional theoretical model of development in Down's syndrome, one preliminary model, which may be helpful to consider, is an adaptation of an infancy model proposed by Moore et al. (2002 - see Figure 1). Moore et al. adapted the approach of Morton and colleagues (Morton & Frith, 1995; Morton, 2004) and explicitly distinguished between levels of explanation, specifically those of neuro-biology, cognition, social behaviour and the social environment. This adaptation builds on Morton's linear causal approach to explaining developmental change, by allowing for multidirectional transactions amongst levels

of explanation, and particularly acknowledges the influence of the child's social environment, over time.

- Insert Figure 1 here -

Starting from the left-hand side of Figure 1, the model attempts to capture the transactional nature of development in Down's syndrome between birth and mid-childhood. It provides an outline of the impact that the over-expression of genes, caused by Trisomy 21, appears to have on brain function and structure. The means by which these impairments then lead to specific differences in aspects of cognitive functioning is not specified in detail, as these relationships have yet to be clearly established. At the cognitive level, Moore et al. (2002) proposed that subtle differences in early attention regulation in infants with Down's syndrome may make them slower to respond and orient in social interactions. This then may elicit a warmer maternal style during interactions that serves to maintain levels of attention. This adapted maternal social style, along with the infants' possible difficulties in switching attention efficiently, may lead the infants to become more focussed on people, particularly the mother, and may serve an important and useful function in developing early emotional attachments (Berry et al. 1980). However, Moore et al. proposed that it may also make infants more likely to become 'locked in' in interactions and depend more on others for regulating their attention, an outer-directedness first highlighted by Zigler (1969) as characteristic of those with intellectual disabilities. This will contribute to a tendency to focus on other people rather than objects, and perhaps lead to the adoption of a strategy of 'over imitation', with infants with Down's syndrome imitating the actions of others in situations where more independent problem-solving would be more appropriate (e.g. Wright et al. 2006). In response to this greater focus on people than objects, and perhaps also in response to

'over-imitation' by the child, it is possible that the mothers not only show greater warmth in interactions, but also begin to adopt a more directive role, leading their infants in social exchanges.

This style of interaction will also impact on joint attention and 'triadic' engagement where attention is to be shared between other people and objects – an important component of shared understanding and language. Subsequently, when 'topic' bids are made by infants with Down's syndrome, they may not be picked up because mothers are continuing to work hard to direct and maintain attention using a forceful but warm affective style. This in turn would explain the findings of reduced frequency of requesting behaviours. Moore et al. suggested that this differential style of engaging in triadic interaction could have consequences for the development of language and other cognitive processes that require a sense of agency – not least the development of means-ends and problem solving functions.

Extending this model here, we additionally suggest the reduced use of mental state and emotion terms by mothers may also, along with other factors, impact on the subsequent development of sensitivities to emotional stimuli in children with Down's syndrome – that is, if mothers are not drawing attention to these events through language then this may reduce the salience of this information. In turn, this may lead to a differential sensitivity to emotional stimuli and difficulties in emotion recognition. However, the subtle difficulties reported to date in emotion recognition are likely to be the result of a number of factors and, as highlighted earlier, the potential role of maternal interactive style should be further explored. The difficulties in emotion recognition, when combined with a reduced sense of agency, may lead to subtle, as yet uninvestigated differences in aspects of theory of mind.

This preliminary model fits with the relatively limited data available on early social cognition in Down's syndrome. It is inevitably somewhat simple and incomplete, with many potential causal links uncharted and more extensive testing of those links which have been proposed clearly required. Further development - for example, incorporating the roles played by other children and adults in the child's wider family, social and educational environment - is needed. An extension of the model into adolescence would also be an obvious next step, stimulating research which will hopefully provide a deeper understanding of the origins of the typically poor social and cognitive outcomes at later ages in children with Down's syndrome, and ideally pinpointing effective intervention strategies which could be implemented at key transitional stages in socio-cognitive development.

What the model does hopefully at least illustrate is how the field might begin to characterise a transactional developmental model of social cognition in Down's syndrome. Further development of this, or of other transactional models using a similar form of notation, would be of potential benefit in that it would allow for empirical testing and more detailed comparative evaluations of different theoretical positions. Ultimately, more detailed transactional models may allow for the development of more theoretically-driven, and possibly more effective, interventions.

## **Conclusions**

Contrary to public perceptions, for many children with Down's syndrome, engaging with others and understanding their emotions and intentions may not be as easy a developmental step as it is for their typically developing peers. It would appear from the evidence available to date



that this area of understanding may be more impaired than would be predicted on the basis of the children's overall levels of cognitive ability.

As with development in other cognitive domains, the development of interpersonal understanding is affected by both biological and environmental factors. The biological mechanisms underpinning the difficulties seen in social understanding in Down's syndrome are unlikely to be open to intervention in the near future, leaving environmentally-based intervention programmes as the more realistic aim. As highlighted in this overview, however, the lack of sufficiently detailed research findings hampers progress at present. Although there have been encouraging advances in delineating the behavioural phenotype of Down's syndrome, there still remains a wide gap between research findings and the development of evidence-based interventions and effective educational approaches for children with Down's syndrome (Davis 2008; Fidler & Nadel 2007). Truly translational research that leads to effective interventions is likely to require the co-ordination of many different levels of explanations of behavioural outcomes in Down's syndrome. This remains the major challenge to progress in this field, and to research in learning and intellectual disabilities in general (Cicchetti & Toth 2009; Diamond & Amso, 2009; Oliver & Woodcock 2008; Pennington 2009).

Undoubtedly, developing a comprehensive explanatory model of social cognition in Down's syndrome which could underpin and drive future research - and ultimately intervention design - presents a considerable challenge, as is illustrated by the incompleteness of the preliminary model proposed above. As can be seen in the fields of autism and Williams syndrome, much progress has been made through theoretically-driven comparative studies of socio-cognitive development which have included comparisons with typically developing

children. This has led to the development of new methodologies and increased rigour, resulting not only in greater explanatory power but also in the cross-fertilisation of theoretical ideas. It seems likely that research into social cognition in children with Down's syndrome would similarly benefit cast within a more theoretical framework.

Some of the most interesting recent findings in the field of intellectual difficulties have come from exploring cross-phenotype developmental trajectories, with particular research interest in autism, fragile X and Williams syndrome, developmental disabilities which present intriguing profiles of social strengths and weaknesses. These reveal more subtle patterns of performance than are often detectable by simply making comparisons with typically developing children (see Karmiloff Smith 2007). However, even with prenatal screening programmes, Down's syndrome continues to represent a very large subgroup of children with intellectual disabilities and if we are to continue to develop more detailed theoretical accounts of Down's syndrome, it is imperative that researchers include these children in these multi-phenotype studies. We hope that this review emphasises that this syndrome presents an equally challenging and potentially unique profile deserving of similar levels of scrutiny. Longitudinal studies would be particularly welcome, as examining how early socio-cognitive abilities relate to interpersonal skills in later childhood and how they support or hinder higher-level socially-based learning is crucial to the design and implementation of future interventions.

Several of the studies included in this review reported wide variation on many developmental measures in children with Down's syndrome, often along with an absence of the clear associations between ability levels in different domains found in typically developing children (e.g. Wishart & Pitcairn 2000; Kasari et al. 2001; Williams et al. 2005). This seems an

area particularly ripe for future cross-phenotype investigation. Such findings suggest that development across domains in Down's syndrome may not be as well integrated as in typical development, which in turn suggests that fundamentally different intervention approaches and pedagogical strategies may be required. On a more positive note, the wide individual variation in level and ages of acquisition of socio-cognitive abilities in children with Down's syndrome indicate that Down's syndrome in and of itself does not necessarily constrain development in this area in any pre-determined way. This leaves room for optimism that a much more detailed account of socio-cognitive development in Down's syndrome could lead to more effective interventions, producing lasting and meaningful benefits.

In sum, we suggest that for significant progress to be made in this field, theorists need to become more engaged in explaining the distinctive socio-cognitive profile of children with Down's syndrome and how this is expressed in their behaviour at different ages. Correspondingly, researchers in the field of Down's syndrome need to engage more with theoretical advances being made in the study of typical socio-cognitive development. In this paper we have highlighted some of the difficulties in social cognition seen in Down's syndrome, but also some of the similarities to typical development, at least in the earliest stages of childhood. We hope that this may encourage renewed interest in studying children with Down's syndrome for their own sake, and not simply as a control group for cognitive impairment in studies of typically and atypically developing children. This, in turn, may lead to new theoretical models capable of accounting for both within and cross-phenotype developmental differences in social cognition.

Harnessing new technologies and innovative paradigms, such as eye-tracking, fMRI, ERP,

EEG and MEG techniques, may also further enhance understanding of socio-cognitive development in Down's syndrome. Although increasingly used in the study of autism and other developmental disabilities, their use to date with children and adults with Down's syndrome has been remarkably limited (for important exceptions see e.g. Karrer et al. 1998; Cheung & Virji-Babul 2008; Virji-Babul et al. 2008). This is unfortunate, as the potential findings from such studies, in combination with a well-differentiated account of the role of the social environment in promoting socio-cognitive development, could well lead both to powerful theories and to more successful intervention strategies.

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Figure 1: A developmental causal model of social cognition in young children with Down's syndrome adapted from Moore et al. (2002)