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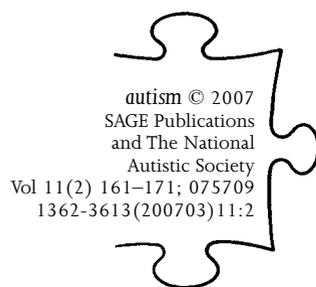
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Restricted object use in young children with autism

Definition and construct validity



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ABSTRACT There are currently no measures of restricted object use in young children with autism. In this study the object play of 27 young children with autism was measured in a semi-structured context to quantify restricted object use. It was hypothesized that children who engaged in less restricted object use would show better responding, joint attention, motor imitation, and intentional communication. Partial correlation coefficients were calculated between restricted object use measured at time 1 and response to joint attention, motor imitation, and coordinated attention to object and person, at time 1 and time 2 (6 months later), controlling for developmental play level. The construct validity of this measure of restricted object use was supported by the statistically significant correlations in the predicted direction of all expected associations.

KEYWORDS
coordinated
attention;
imitation;
joint
attention;
restricted
object use;
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Social learning deficits in autism

Autism has been conceptualized as a social learning disorder indicated by impairments in social attention, orienting (Dawson et al., 2004; Landry and Bryson, 2004) and processing (Klin et al., 2002). Children with autism show deficits in several social learning skills including (1) a failure to respond to bids for joint attention (Mundy et al., 1994; Sigman and Ruskin, 1999), (2) deficits in motor imitation (Stone et al., 1997a), and (3) deficits in coordinated attention to object and person (Adamson et al., 2004; Stone et al., 1997b). These deficits in social learning skills have been hypothesized to fuel a negative feedback loop leading to secondary neurological disturbances in autism (Mundy and Neal, 2001). Deficits in social learning skills may be inversely related to restricted object use. For example, children with

autism that have very restricted object use may have fewer opportunities to practice social learning skills and therefore may show more severe deficits than children with less restricted object use.

Definition of restricted object use

We define restricted object use as action schemata and/or toy preferences that are restricted in range and make up a large portion of the child's differentiated intentional actions directed toward objects. Although this construct is new to the literature, it is conceptually related to (1) excessive interest in particular objects (Wetherby et al., 2004) and (2) restricted interest (American Psychiatric Association (APA), 2000). Restricted object use may be more useful than 'excessive interest in particular objects' because the construct is an observable behavior in contrast to the unobservable construct 'interest'. Restricted object use may be a developmentally earlier form of restricted interests as defined in the *Diagnostic and Statistical Manual*, fourth edition text revision (American Psychiatric Association, 2000). This article will describe a measure of restricted object use and test its construct validity using Cronbach and Meehl's (1955) nomological network approach.

Nomological network approach

The construct validity of a target measure is determined by the network of associations between the target measure and established measures of constructs to which the target construct is theoretically related (i.e. the nomological network). The theoretically related constructs are the 'nodes' in the nomological network. Statistically significant nomological network associations in the predicted direction (positive or negative) define the boundaries of a construct. There is no requirement that the nomological network identify variables that explain all or most of the variance in any of the variables in the network. The construct validity of the target measure is decided by the number of correlations in the network that are statistically significant and in the predicted direction.

Relationship between restricted object use and the predicted associations

When children with autism are engaging in restricted object use their capacity to disengage from an attentional focus and search and select among salient attentional targets may be reduced (Posner and Dehaene, 1994). One heuristic that is useful for thinking about this type of attentional disorder is as an increase in the use of the attentional spotlight and a decrease in the use of the attentional searchlight. So, whereas children with functional attentional searchlights will scan the environment looking for salient attentional cues like an adult's conventional gesture, children

with reduced attentional searchlights will miss many attentional cues in the environment. When children are engaging in restricted object use they focus their attentional spotlight on the object they are manipulating and do not use their attentional searchlight. In the current study we will examine the effect of reduced use of the attentional searchlight, as a result of restricted object use, on several social learning variables including: joint attention, motor imitation with objects, and communication acts with coordinated attention to object and person. These social learning variable nodes are related to the target construct, restricted object use, because they represent events that require that the child orient to the model before they can get the information from the model.

Response to joint attention (RJA) occurs when children direct their attention to a referent based on an attentional cue. Children who can be directed to a referent have more access to information (e.g. how to play with the referent) than children whose attention is generally not influenced by the adult's attentional cues. RJA is a deficit in children with autism, especially in children with mental ages less than 20 months (Mundy et al., 1994). A critical piece of RJA is the recognition of the adult's attentional cue and shifting attention to the target that is indicated by the communicative partner. We predict that children with relatively high levels of restricted object use will show relatively low RJA.

Motor imitation occurs when one person reproduces parts of the motor act of another person. For imitation to occur, children need to attend to the motor acts of other children or adults. Through imitation we learn to regulate our emotions and to understand the emotions of others, and we learn new behaviors (Meltzoff and Moore, 1999). Children with high levels of restricted object use may be less likely to attend to the motor acts of other adults or children in comparison to children with lower levels of restricted object use. This reduced attendance to motor acts may reduce the number of opportunities to practice motor imitation skills and thereby reduce opportunities to acquire imitative skills.

Coordinated attention is the use of gaze or gesture to show attention to an object and a person within the same communication act (e.g. three-point gaze between object and person). Through coordinated attention, children communicate their interests to parents and receive information about their interests through adults' descriptive talk and labels (Bakeman and Adamson, 1984). Children with high levels of restricted object use may have difficulty shifting attention between an object and a person in a way that they can communicate their intentions about the object to the adult.

Developmental play level Developmental play level quantifies the sophistication of object use and object knowledge, Children change the way they

use objects as they learn more about object properties and functions (Lifter, 2001). Restricted object use is thought to be associated with developmental play level because children with relatively low restricted object use have more opportunities to learn about object properties and functions. Restricted object use is distinguished from developmental play level by the equal possibility of restricted object use at all levels of play. For instance a child with a high developmental level of play may perseverate on having a puppet repeat a scripted phrase to the exclusion of engagement with other toys or people. A child with low developmental play level may spin the majority of the toys with which he engages, making it difficult to break into his play to redirect him. Because we are interested in measuring the effect of restricted object use on the nodes in the nomological network above and beyond the effect of developmental play level, we will control for developmental play level when we measure the associations.

Summary

In summary, this article will test the construct validity of a new measure of a new construct: restricted object use in young children with autism. The theory used to identify the 'node' variables indicates that increased levels of restricted object use result in increased difficulty in disengaging attention and resultant reduced availability of attention for scanning and selecting among other environmental stimuli. Because attention to the environment is necessary to learn from modeled events, this reduced attentional ability leads to a decrease in processes that enable social learning, including response to joint attention, motor imitation, and coordinated attention to object and person. We predict that restricted object use will be significantly and negatively correlated with responding to joint attention, motor imitation scores, and frequency of coordinated attention to object and person, controlling for developmental play level.

Methods

Participants

The participants of this study included 27 prelinguistic children identified with an autism spectrum disorder based on the Autism Diagnostic Observation Schedule (ADOS: Lord et al., 2000) and clinical judgment by an expert in early diagnosis of autism in young children. See Table 1 for descriptions of the participants. In terms of demographic variables, 86 percent were male; 65 percent were Caucasian, 17 percent were African American, and 17 percent were classified as 'other'.

Table 1 Description of sample (*n* = 27)

<i>Variable</i>	<i>Mean</i>	<i>SD</i>
Chronological age	33.6	8.95
Mental age ^a	15.8	2.8
Full scale intelligence quotient ^a	50.2	4.6
Language age: ^b		
Receptive	11.66	3.6
Expressive	11.62	3.9
ADOS:		
Social algorithm	11.03	1.98
Communication algorithm	6.16	1.14
Restricted and repetitive behavior subscale	2.33	1.49
Total	17.19	2.23

^a Scores from the Mullen Scales of Early Learning.

^b Age in months.

Design and procedures

A two-time-point longitudinal correlational design was used. The procedures used were (1) Developmental Play Assessment (DPA: Lifter, 2001), (2) Early Social and Communication Scales (ESCS: Mundy et al., 1996), and (3) Motor Imitation Scale (MIS: Stone et al., 1997b). The DPA was administered at time 1 only and the ESCS and MIS were administered at times 1 and 2 (6 months delay).

Developmental play assessment Restricted object use and developmental play level were measured during an adapted version of the DPA, a semi-structured object play situation where the examiner presents three sets of toys and allows the child to explore each set for approximately 5 minutes. During our adaptation of the DPA, the examiner is instructed not to model any play behaviors for the child but is allowed to imitate the child's behaviors. The same procedure and toys were used with all participants.

DPA data were recorded from a video record of the session using a software application called Playcoder that was designed and created for use with the DPA (Tapp and Yoder, 2003). When the rater sees a play action he or she thinks may be an anticipated action with one of the experimental materials, he or she selects the toy set that the child was using, selects the particular toy the child touched from the toy set, and indicates the action used. The anticipated actions are only those indicated on a list of anticipated play actions that children typically perform on the toys included in the assessment. The list of anticipated play actions includes both undifferentiated and differentiated actions. Undifferentiated play actions are simple actions that can be applied to toys regardless of their properties (i.e. shaking,

banging, and mouthing; Lifter, 2001). Differentiated play actions are defined as play actions that require some knowledge of the play material (i.e. stacking blocks) that have been constructed from past work with children with autism observed in this procedure and with these materials. The software uses a programmed algorithm to identify the child's emerging and mastered play level based on Lifter's (2001) original coding system. The frequency statistics in the software report include number of times each toy was touched, number of times each action was performed on a toy, and total number of toys touched. It also creates an Excel spreadsheet of the child's data that can be pasted into the main spreadsheet, reducing data entry errors.

Restricted object use The restricted object use variable was the proportion of touched toys on which the child performed at least two differentiated play actions. This metric was chosen because it provides a measure of the diversity of the toys on which the child performs more than one differentiated action. Only toys on which children used differentiated actions were counted in the numerator because when a child performs a differentiated action on a toy s/he demonstrates some knowledge of the toy's functions, not just exploration of the sensory characteristics of the toys. It was reasoned that knowledge of object functions was an intrinsic aspect of less restricted object use. The requirement that toys included in the numerator had to have at least two differentiated actions attempts to exclude toys on which children accidentally demonstrated a differentiated action on the toy. The usual meaning of 'restricted' requires that we quantify the number of toys with which children display differentiated actions. A second coder independently coded a random sample of 20 percent of the testing sessions. An intraclass correlation coefficient of 0.81 was calculated between the primary and reliability coder's estimate of restricted object use.

Developmental play level The assignment of developmental play level mastered was based on the categories developed by Lifter and Bloom (1989). For a play level to be coded as mastered, a minimum of 10 occurrences of actions included in that level are required including at least four different actions. Play level was calculated using a computer algorithm, reducing the error inherent in human assignment of play level. There are eight play levels ranging from indiscriminate actions to sociodramatic/thematic fantasy play. The levels are based on the order of emergence of play behaviors from late infancy to preschool using a cognitively oriented category scheme. A second coder independently coded a random sample of 20 percent of the testing sessions. An intraclass correlation coefficient was calculated between the primary and reliability coder of 0.95 for developmental play level mastered.

Early Social Communication Scales (ESCS) RJA and coordinated attention were measured during the ESCS, a structured communicative context designed to elicit social and communicative bids and to elicit responses to examiner's bids for attention. The test is administered at a table and the experimenter is seated across from the child with tempting toys placed out of the child's reach to encourage requesting and commenting (Mundy et al., 1996).

Response to joint attention (RJA) The RJA trials are embedded in several other probes of social communication. During an RJA trial the experimenter points to a picture on the wall and calls the child's name three times. The trial is repeated eight times. A response is considered correct if the child looks to the picture that is the experimenter's point of focus. The RJA score is calculated as the number of correct responses divided by the number of opportunities. A second coder independently coded a random sample of 20 percent of the testing sessions. Intraclass correlation coefficients were calculated between the primary and reliability coder at time 1 (i.e. 0.73) and at time 2 (i.e. 0.96).

Coordinated attention to object and person A child was coded as demonstrating a communication act when they used a symbolic (i.e. a word, an American Sign Language sign) or conventional act (i.e. conventional gestures such as distal point), or an unconventional gesture or non-word vocalization that was combined with showing attention to an adult. Communication acts were further coded as having coordinated attention to object and person if the act included attention to object and attention to person within 3 seconds of each other without the adult's intervening behavior drawing the child's attention to the second item. Attention to object was defined as looking at an object, actively touching an object, or referring to an object with a word, sign, or picture. Attention to person was defined as looking to the adult's face, giving an object to an adult, or touching an adult. A second coder independently coded a random sample of 20 percent of the testing sessions. Intraclass correlation coefficients that were calculated between the primary and reliability coder for coordinated attention at time 1 and time 2 were 0.97 and 0.93, respectively.

Motor Imitation Scale (MIS) The MIS is a 16-item assessment of motor imitation designed for use in young children with autism (Stone et al., 1997a). The items are presented in a structured, but playful, context. The experimenter demonstrates the item for imitation, saying 'do this' or 'do what I do'. The child's response is then scored on a scale from 0 to 2 with 0 = failure to imitate, 1 = an emerging response, and 2 = a passing

response. Motor imitation is operationally defined as the sum of the child's best performance score from each of the 16 items on the MIS. The authors of the MIS report acceptable internal consistency ($\alpha = 0.87$) and an acceptable 2-week test-retest reliability coefficient of 0.80 in young children with autism (Stone et al., 1997b).

Analysis

Partial correlations, controlling for developmental play level, were calculated between restricted object use at time 1 and RJA, motor imitation, and coordinated attention to object and person at times 1 and 2. Two subjects were not administered the RJA assessment at time 1 and were excluded from the analysis at both time 1 and time 2, which reduced the number of subjects in those analyses to 25.

Results

All correlations in the nomological network were significant ($\alpha = 0.05$) and with the predicted algebraic sign (see Table 2). The restricted object use variable was approximately normally distributed with a mean of 0.21 and a standard deviation of 0.15. The correlations were all in the moderate range of effect size (Cohen, 1988). The power to detect the alternative hypothesis at $\alpha = 0.05$ was between 0.44 and 0.68.

Discussion

These results support the construct validity of this new measure of restricted object use. This is the first evidence of construct validity for any measure of restricted object use in the literature. The results support the hypothesis that children who spend a relatively large proportion of time engaged in restricted object use are less aware of adult attentional directives (as seen

Table 2 Correlation coefficients and confidence intervals (CI) for the correlations with restricted object use

Variable	Time 1			Time 2	
	<i>n</i>	<i>r</i>	95% CI	<i>r</i>	95% CI
RJA	25	-0.39*	-0.02 to -0.67	-0.42*	-0.05 to -0.69
Motor imitation	27	-0.44*	-0.07 to -0.70	-0.49**	-0.14 to -0.74
Coordinated attention to object and person	27	-0.38*	-0.01 to -0.66	-0.47**	-0.11 to -0.72

* $p < 0.05$; ** $p < 0.01$.

in RJA), adult prompts (as seen in imitation tasks), and models to imitate (as seen in the imitation task). Similarly, children who spend a relatively large proportion of time engaged in restricted object use are less likely to show attention to adults while attending to objects and thus less likely to show coordinated attention between objects and people. This reduction in attention to adult models and information about objects is likely to reduce the number and quality of their learning opportunities, possibly resulting in secondary neurological deficits (Mundy and Neal, 2001). These associations occurred even after controlling for developmental play level.

Restricted object use may be a constraint on the development of children with autism. The dynamical systems model is helpful in understanding the interaction between constraints on development like restricted object use and the acquisition of skills. In dynamical systems theory, development is a self-organizing process where more complex states emerge when less complex states are displaced (Hopkins and Butterworth, 1997; Seidenberg, 1997). This displacement occurs when perturbations from the environment cause a state of disequilibrium that weakens constraints on the system. If restricted object use and other constraints are changed through treatment or development over time, representing a perturbation, the probability of development in important areas like social communication or play is improved.

A general characteristic of a constraint-based approach to development is that interactions between constraints are non-linear and combining several weak constraints can result in a strong constraint on the system (Seidenberg and MacDonald, 1999). The power of restricted object use as a constraint on development in children with autism may come from its co-occurrence with other deficits like gaze irregularities and social anxiety (Dalton et al., 2005; Klin et al., 2002). Restricted object use may be less of a constraint on development in other ability groups because it may not co-occur with other constraints in those populations. Therefore, restricted object use is particularly important in children with autism because it frequently co-occurs with other constraints.

The weaknesses of this study are a small sample size and a relatively weak research design (Campbell and Stanley, 1963). The small sample size compromises statistical power and results in large confidence intervals around the correlation coefficients. Assuming a moderate population correlation of 0.40, a sample of 47 children would be required to detect this correlation as different than 0 (Cohen, 1988). Despite this low power, we detected all predicted associations as significant and with the predicted algebraic sign. However, the large confidence intervals around the correlation coefficients remind us that the population association between restricted object use and the node variables (i.e. RJA, motor imitation, and

coordinated attention) may be quite a bit smaller or larger than we estimated in our small sample.

The correlational design used in this study was sufficient for garnering evidence that supports construct validity (Cronbach and Meehl, 1955) but is insufficient to infer that restricted object use has a negative, causal influence on social learning variables. The theory used to connect the nodes in the nomological network of restricted object use is validated only to the extent that it predicted the algebraic signs and non-zero magnitude of the correlations.

The strength of this study is in the development of a measure of restricted object use and test of its construct validity. This measure could be useful in evaluating the effects of play treatments in children with autism and could be a predictor of treatment response for social communication treatments. Reducing restricted object use may increase the availability of attention to the environment and increase opportunities for imitation, RJA, and coordinated attention. Continued research in this area should directly measure the effects of restricted object use on development.

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