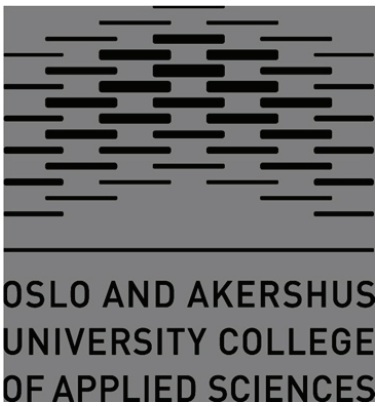
Reinforcers as Predictors of Outcome in Behavioral Interventions for Autism

Lars Klintwall



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Abstract

There is ample support for interventions based on Applied Behavior Analysis as effective in teaching children with autism skills that they lack. However, studies consistently report large variations in outcomes. Given the central role of positive reinforcement in behavior analytic treatments, a series of studies were conducted to test the hypothesis that children whose behavior is reinforced by a large range of stimuli will benefit more in treatment. Using a new outcome metric, learn rates, this hypothesis was confirmed in two studies. One study employed adult reports on child reinforcers, and a second study utilized a novel scoring system for direct evaluation of child behavior in an already existing, and widely used, structured assessment. Building on these findings, we go on to suggest that the concept of reinforcement can be used to construct a behavior analytic theory for the etiology of autism, compatible with what is known about genetics, early signs and plasticity of autistic symptoms.

Acknowledgements: Klara, som alltid.

Contents

Autism is a developmental disorder defined as a deficit in social skills (e.g. language) and the presence of stereotypic behavior such as repetitive mannerisms or narrow interests. Although first described as a distinct syndrome in the 40s, research on causes and potential treatments for autism started mainly in the 60s, and has since continued to grow. Presently, the interventions for autism with the best support are those based on Applied Behavior Analysis (ABA), with the theoretical and philosophical foundation of behaviorism. The present dissertation will describe autism from a behavior analytic perspective, the treatments available, and how they can be improved using behavior analytic research and conceptualizations.

1. Interventions for autism

What follows is a brief introduction to the diagnosis of autism, a description of behavioral interventions for the disorder, and the scientific support for their effectiveness.

1.1 Autism

1.1.1 Diagnostic Criteria

In 2013, a new edition of the Diagnostic and Statistical Manual of Psychiatric Disorders (DSM-5) was published. The DSM is by far the most widely used manual for diagnosing psychiatric disorders, both in clinical and scientific work. This new and fifth edition of the DSM defines autism as following (paraphrased from American Psychiatric Association, 2013):

A. Deficits in social communication and social interaction across contexts.

B. Restricted, repetitive patterns of behavior, interests, or activities.

C. The symptoms above present already in early childhood.

D. These symptoms limit and impair everyday functioning.

E. The symptoms are not accounted for by a global developmental delay.

Note that, like all psychiatric disorders, autism is defined by behavioral symptoms. The most important differences between the current version of the diagnostic criteria for autism and those presented in the previous, fourth edition, is that deficits in communication and deficits in social interaction have been combined into one criteria, and that previous subcategorization within the autism spectrum (e.g. Aspergers syndrome) has been collapsed into one. For children with a global developmental delay ("intellectual disability" in the DSM-5), the deficits in social skills must be below that global developmental level.

1.1.2 Prevalence and comorbidity

The prevalence of autism has increased considerably since the disorder was first suggested in the 1940's, prompting talk of an autism "epidemic". Currently, autism is said to

have a prevalence rate of about 2 in 100 children (Kim et al., in press). Suggested causes for the increase in prevalence have been infant vaccines, food toxins, and even cable TV (Waterhouse, 2008). Perhaps more reasonable explanations are change in diagnostic criteria and both public and professional awareness of the diagnosis (Waterhouse, 2008). For instance, it has been shown that increases of autism in areas are associated with a decrease of other neurodevelopmental diagnoses, such as mental retardation (Shattuck, 2006). The observation that autism prevalence rates fluctuate over time is not surprising, given the subjective nature of the diagnostic criteria listed above. For example, the cut-off for when a child is said to have symptoms limiting and impairing everyday functioning is by necessity arbitrary (Klintwall, 2012).

1.1.4. Etiological Theories

It is known that autism is heritable. For instance, when one child is diagnosed with autism, the risk of younger sibling receiving the same diagnosis increases (Muhle, Trentacoste, & Rapin, 2004). Twin studies, comparing monozygotic and heterozygotic twins, have given heritability estimates as high as 90 % (Muhle et al., 2004; Ozonoff et al., 2011), but also as low as 37 % (Hallmayer et al., 2011). Although this central role of genetics in the etiology of autism is not controversial, early hopes for identifying responsible specific genes have been disappointed. Autism can be caused by either accumulation of mutations inherited from both parents, de-novo mutations in the individual (such as fragile-X), or X-chromosome mutations inherited from an unaffected mother (Waterhouse & Gillberg, 2014). Cases of autism in families with previous diagnosed individuals are called multiplex cases, and are assumed to be caused by many genes. A smaller group, 5-10 % of cases, come from families with no such elevated risk, and are called simplex families. Mutations in at least 1000 genetic loci can contribute to the development of autism (Pinto et al., 2014).

Different cases will likely have different etiologies (Waterhouse, 2008). From a developmental perspective, such as behavior analysis, autism is seen as a disorder emerging throughout development (Kiaei & Pelaez, 2011; Novak & Pelaez, 2004). Autism can be seen as a lack of acquiring social behaviors (Dawson, Bernier, & Ring, 2012). This diminished or slow learning has been suggested to be caused by an innate low social motivation, a theory called the Social Motivation Hypothesis (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012).

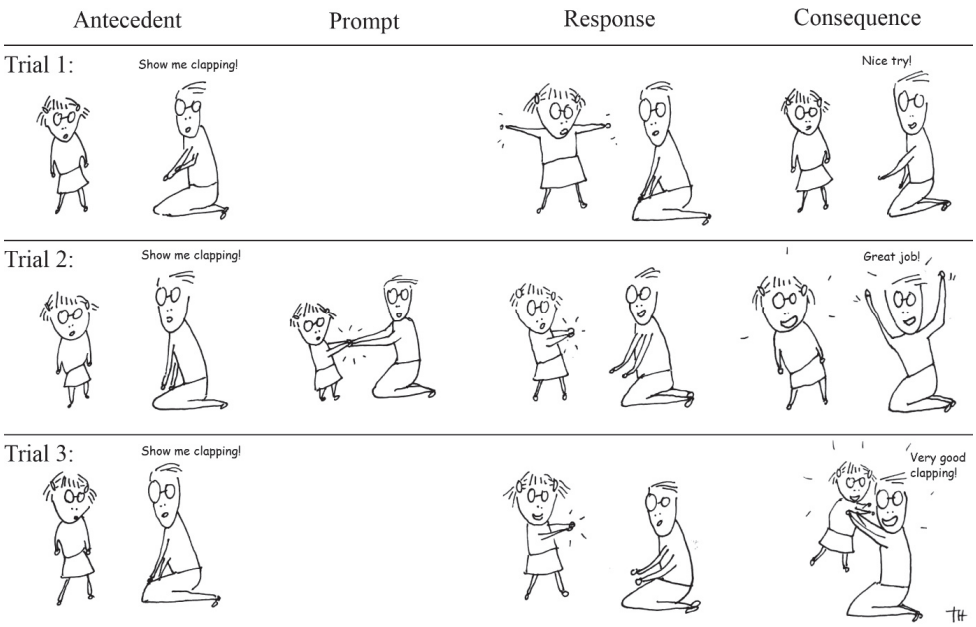
1.2. Behavioral Interventions for Autism

1.2.1 Description of behavioral interventions

Although once considered a chronic and treatment resistant disorder, it is today recognized that autistic symptoms are amenable to interventions. Starting in the 60's (Colligan & Bellamy, 1968), behavioral interventions have been developed that help children with autism to develop language, play skills, academic skills and self-help skills such as dressing and eating (Eldevik et al., 2009; Reichow, Barton, Assouline, & Hume, 2012; Rogers & Vismara, 2008). Although such interventions may decrease autism symptoms such as stereotypic behaviors (Eikeseth, Klintwall, Jahr, & Karlsson, 2012), the aim of behavioral interventions is typically to *increase* the size of the behavioral repertoire of the child (Klintwall & Eikeseth, 2014). This is achieved by carefully teaching the child lacking skills, in small components which can later be combined into functional behaviors (e.g. teaching phonemes which can later be combined into words, which can then be combined into sentences, which then in turn can be used in scripted social interactions). An example of a formalized technique for teaching new skills is Discrete Trial Teaching (Eikeseth, Smith, & Klintwall, 2014), which is illustrated in Figure 1. Techniques such as prompting, prompt fading, differential and positive reinforcement and planned generalization of skills from the training situation to natural settings are employed to ensure efficient learning. Efficient interventions tend to start early and be delivered with high intensities (Eldevik et al., 2009).

Figure 1. Illustration of Discrete Trial Teaching

In trial #1, the teacher produces the antecedent; "Show me clapping". Since the child does not produce the target response, no consequence is given. Thus, on trial #2, the teacher prompts the target behavior physically and then reinforces the produced response (albeit only verbally). In trial #3, the child produces the target response independently (the prompt was effective), and hence the consequence is ample reinforcement (being lifted into the air). In the future, clapping is more likely to be evoked by someone saying "show me clapping". Illustration by Tale Hendnes. Previously published in Klintwall and Eikeseth (2014).



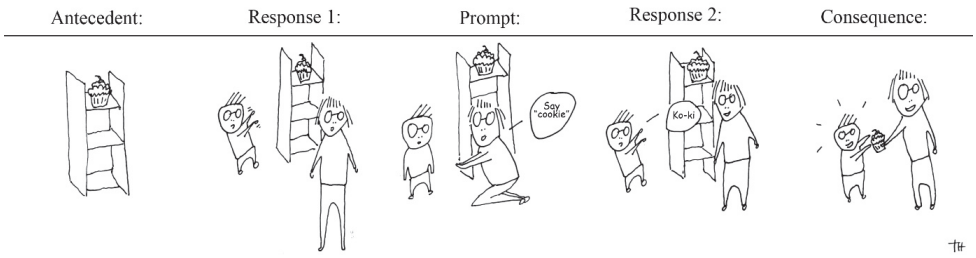
1.2.2. Types of behavioral interventions

There exists a range of programs, all based on the theoretical foundation of behavior analysis, but differing in their mode of delivery. Examples are Early and Intensive Behavioral Intervention (EIBI; Lovaas, 1977, 1981, 2003), Pivotal Response Training (PRT; Koegel & Koegel, 2012), Discrete Trial Teaching (DTT; Eikeseth et al., 2014), the Early Start Denver Model (ESDM; Smith, Rogers, & Dawson, 2008), Picture Exchange Communication System, (PECS; Bondy & Frost, 1994), Princeton Child. Development Institute (PCDI; McClannahan & Krantz, 1994) and Incidental Teaching (IT; Hart & Risley, 1982; illustrated in Figure 2). These models are typically used in conjunction with each other, and they all have in common

their theoretical foundation in Applied Behavior Analysis (ABA). One common ingredient, based on ABA, is the structured use of positive reinforcement (rewards).

Figure 2. Illustration of Incidental Teaching.

The teacher has arranged a situation that is likely to evoke a communicative initiative from the child: putting a cookie within sight but out of reach. The child communicates by pointing, and the teacher then prompts a more elaborated communicative behavior ("Say 'cookie'!"). Although the child only approximates this ("ko-ki"), the teacher reinforces this behavior by giving the child the cookie. In the future, unreachable cookies are likely antecedents for saying "ko-ki", which can then be prompted to be even more elaborated. Illustration by Tale Hendnes. Previously published in Klintwall and Eikeseth (2014).



1.3. Effectiveness of behavioral interventions

1.3.1. Outcome studies

In a recent Cochrane-report, carried out by Reichow, Barton, Boyd and Hume (2012), five randomized or quasi-randomized controlled studies, considered high quality, comparing EIBI for children under the age of 6 years with waiting-lists conditions or treatment-as-usual were analyzed (Cohen, Amerine-Dickens, & Smith, 2006; Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Magiati, Charman, & Howlin, 2007; Remington et al., 2007; Smith, Groen, & Wynn, 2000). The first study, Smith et al, 2000, compared 15 children receiving EIBI with 13 children receiving parent training. Results favored the EIBI-group in measures of IQ, but not adaptive behaviors. Howard et al (2005) compared 29 children who received EIBI with 16 children who received treatment-as-usual in the public school system. Results favored the EIBI group, both as measured by IQ and adaptive behaviors. Cohen et al (2006) compared 21 children in EIBI with 21 children receiving treatment-as-usual. Again, results favored the EIBI

group, both IQ and adaptive behaviors. The study by Magiati et al (2007) compared an EIBI group of 28 children with a treatment-as-usual group of 16 children. Results did not differ between the two groups. Finally, Remington et al (2007) compared 23 children receiving EIBI with 21 children in treatment-as-usual. Results favored the EIBI group, both for IQ and adaptive behaviors. For a summary, see Table 1. Based on these studies, with a total of 203 participants, the authors of the Cochrane report recommend EIBI as a treatment for children with autism, although they also stress the need for more studies of high methodological quality.

Table 1. EIBI outcome studies included in Cochrane report.

Study	Size	Age at intake	Treatment hours/week	EIBI results	Comparison results
Smith, Groen & Wynn (2000)	28	3.0	25	IQ: +16 VABS: -2	IQ: -1 VABS: -7
Howard et al (2005)	61	2.8	25	IQ: +31 VABS: +11	IQ: +9 VABS: -2
Cohen et al (2006)	42	2.8	38	IQ: +25 VABS: +10	IQ: +4 VABS: -3
Magiati et al (2007)	44	3.4	32	IQ: -5 VABS: -2	IQ: 0 VABS: -7
Remington et al (2007)	44	3.1	25	IQ: +12 VABS: -1	IQ: -2 VABS: - 2

In a similar literature review by Eikeseth (2009) comparing the evidence for different comprehensive treatments for autism, the author conclude that EIBI currently is the treatment program with the best evidence. An updated literature review in 2014 did not change this conclusion (Eikeseth & Klintwall, 2014). Similar conclusions have been drawn in many reviews, although the recommendation typically is of behavioral interventions generally, not necessarily EIBI (Howlin, Magiati, & Charman, 2009; Rogers & Vismara, 2008).

1.3.2. Distinction relative/absolute outcome

There are broadly two types of outcome figures in psychotherapy research: relative outcome and absolute outcome (Jacobson & Truax, 1991). Relative outcome describes the change of scores in a (often standardized) scale. Absolute outcome describes the proportion of participants who achieve some specified level of functioning, such as scores below a cut-off in a severity-scale, proportion achieving some ecological measure of typical functioning (such as attending school without assistance), or IQ-scores within the normal range. Outcome studies of

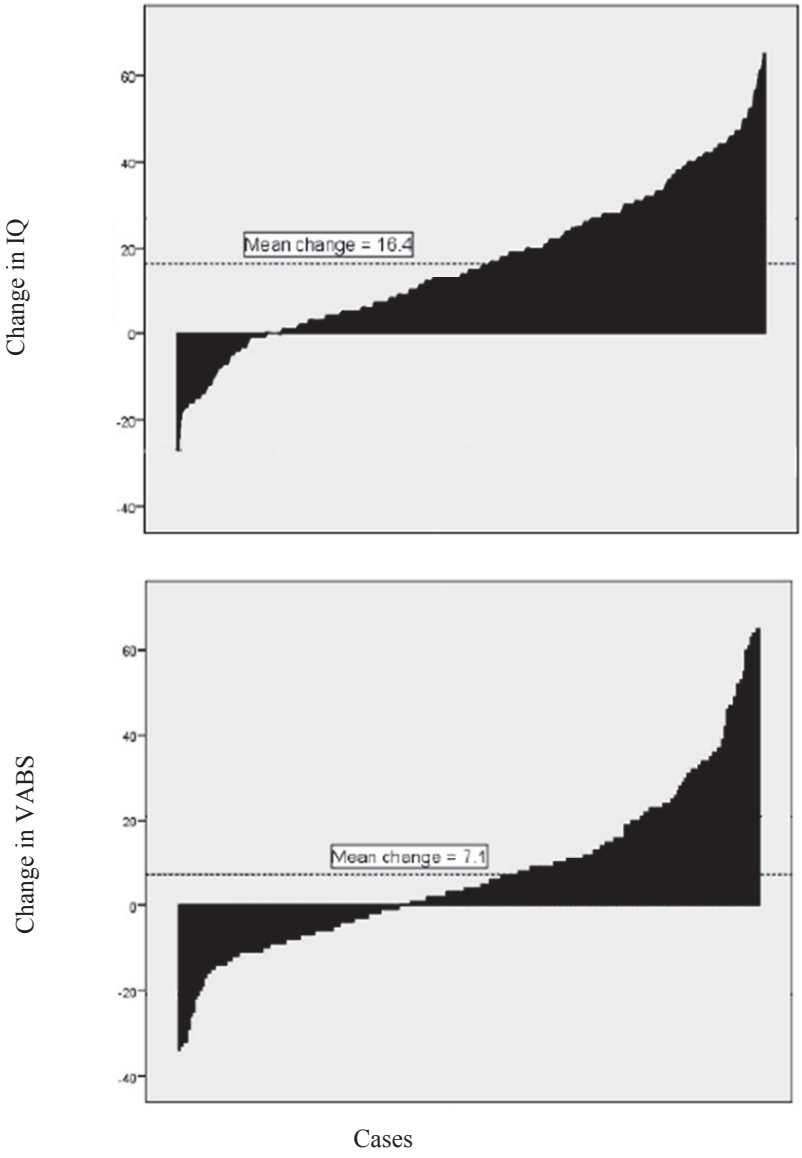
comprehensive behavioral intervention programs (such as EIBI or ESDM) differ in what metric they use, and sometimes use both (e.g. Lovaas, 1987). With relative outcome measures, different participants with different intake levels can be compared. For instance, if one child changes her IQ scores from 40 to 60, and another child from 60 to 80, the relative change is said to be equal (they both improved 20 points in standard scores). In a relative sense, the treatment was equally successful for both children. In an absolute sense, on the other hand, only the second child achieved normal functioning after treatment (defined as IQ > 70). Both types of outcome measures are interesting but should not be confused with each other. Parents are likely more interested in absolute outcome measures (e.g. "what is the probability that my child will attend normal school?"), whereas researchers seems to prefer relative outcome measures (e.g. "what is the mean change in standard scores after this treatment?").

1.3.3. Variability in treatment outcomes

Although many studies have reported on the beneficial effects of behavioral interventions on group levels, a consistent finding is a large variation in individual gains (Dawson et al., 2012; Howlin et al., 2009; Warren et al., 2011). Some children make large gains in treatment, whereas others learn less, and a small minority seems to benefit little at all from treatments. An example can be found in a study by Eldevik et al (2010), which analyzed individual participant data for 309 children who had been described in published outcome studies on behavioral interventions. On a group level, the children made large gains in both IQ (mean 16.4 standardized points) and adaptive behaviors (mean 7.1 standardized points). However, the range of outcomes was large indeed, with IQ points changing from a negative 25 to an increase of over 60. In adaptive behaviors, the range of changes was from a negative 30 to an increase of over 60. This is illustrated in Figure 3. This variation in outcomes has prompted an interest in predictors that would explain which children will benefit the most from behavioral interventions. If powerful predictors could be identified, this could possibly be used as a differential diagnosis and focused research on interventions for the sub-group of children who benefit less from existing treatments.

Figure 3. Individual outcome data for children in EIBI

Every black vertical line denotes one child who has received EIBI (n=309). Adapted from Eldevik et al (2010). Top panel shows change in IQ scores, and bottom panel shows change in adaptive behavior standardized scores. Note the large variation in outcome.



1.4 Predictors of Outcome in behavioral interventions

Several variables have been suggested as predictors of treatment outcome for children in behavioral interventions. Below, some studies on the most commonly suggested are reviewed, but many more has been suggested in the literature, such as parent stress (Osborne, McHugh, Saunders, & Reed, 2008), frequency of supervision for teachers (Eikeseth, Hayward, Gale, Gitlesen, & Eldevik, 2009), and physical abnormalities indicative of syndromal disorders (Stoelb et al., 2004).

1.4.1. Age at Treatment Onset

From a theoretical perspective, young age at start of intervention would seem to be important. For neurological reasons, plasticity is supposed to be higher at younger ages, and from a behavior analytic perspective, younger children have not yet "crystallized" their behavioral patterns. For this reason, many studies have investigated age as a predictor of outcome. For instance, Harris and Handleman (2000) found that young age at start of treatment predicted better outcomes, in an absolute sense, as measured by school placement. A similar study was carried out by Fenske et al (1985), comparing children who started treatment either before or after the age of 5 years. Results showed that children in the early group had more positive outcomes, as indicated by school placement. However, studies have failed to replicate intake age as a predictor of relative outcome (Eikeseth, Smith, Jahr, & Eldevik, 2002; Magiati et al., 2007).

1.3.2. Intake IQ

Intake intellectual functioning has been investigated as a predictor for outcome in a range of studies. Not surprisingly, high IQ at intake is a strong predictor of high functioning at end of treatment (Harris & Handleman, 2000), an example of an absolute outcome measure, (as described above). IQ also appears to be a predictor of relative outcome, so that high IQ at intake predicts gaining more IQ-points in treatment (Ben-Itzchak, Watson, & Zachor, 2014; Ben-Itzchak & Zachor, 2007). However, other studies have failed to replicate this finding (Cohen et al., 2006; Sallows & Graupner, 2005; T. Smith et al., 2000), including the Eldevik (2009) meta-study, making intake IQ an uncertain predictor of outcome.

1.3.3. Intensity of Intervention

Reed, Osborne and Corness (2007) compared high-intensity (30 hrs/week) with low-intensity (12 hrs/week) EIBI, for 14 and 13 children with autism respectively. Results showed that the high-intensity group made significantly larger gains. In the meta study by Eldevik et al (2009) described above, intensity of treatment was found to be the only consistent predictor of treatment outcomes, both as measured with IQ and adaptive behaviors.

1.3.4. Initial response to treatment

Not surprisingly, initial response to treatment is a strong predictor of subsequent gains. For instance, Weiss (1999) reported that rapid acquisition of verbal imitation and responding to verbal instructions predicted treatment outcome two years later. Similar results were reported in the Sallow and Graupner (2005) study described above.

1.3.5. Comparable predictors

In order to compare predictors across studies, results must be reported in some standardized format. For instance, explained variance (r^2). However, only a few studies report this. One example is Eldevik et al (2010), analyzing outcomes for 309 children also investigated intake age, IQ, adaptive functioning and treatment intensity as predictors of outcome. Results showed that these variables taken together explained 20 % of the variance in treatment outcome as measured as change in adaptive functioning, and 7 % of the variance in treatment outcomes as measured as change in IQ. In the study by Weiss (1999) described above, early response to treatment explained 71 % of the variance in subsequent outcome, measured as adaptive functioning.

2. Reinforcement

Positive reinforcement is used in all behavioral interventions, and is supposed to be essential for treatment. Perhaps then, the extent and frequency of situations in which positive reinforcers can be used with any one child might predict outcome for that individual. In the following, the concept of reinforcers is expanded upon, and the potential use of individual differences in reinforcer breadth or intensity as a predictor of outcome in behavioral interventions is outlined.

2.1. The concept of reinforcement

2.1.1. Definitions

A *reinforcer* is any stimulus which increases the probability of the operant (class of responses) that consistently precedes its presentation. A punisher is any stimulus which decreases the probability of the operant that precedes its presentation (Moore, 2008). When the reinforcing effect comes from a stimulus being presented, this is called positive reinforcement. Positive in this context means adding something to the situation. Negative reinforcement is the opposite, when the reinforcing effect comes from something punishing is removed. The effect on responses varies by degrees, giving reinforcers different strengths, so that stimuli, in this model, are somewhere on the unitary dimension between positive and negative (Premack,

1971). Strength can be seen as a continuous value, with zero being the equivalent of a theoretically neutral stimulus (Mechner, 2011). Reinforcer strength should not be mistaken with stimulus magnitude, the amount or intensity of a stimulus. Stimuli may acquire a positive or negative reinforcing strength through conditioning: by systematically predicting (Balsam & Gallistel, 2009; Schoenfeld, 1978) other stimuli which already have a reinforcing strength or responses that produce such stimuli: for example, a tone can be conditioned to food (and become a positive reinforcer) or be conditioned to an electric shock (and become a negative reinforcer). Sometimes stimuli may acquire reinforcing properties by mere exposure, such as in imprinting (Peterson, 1960). Either way they are called conditioned or secondary reinforcers. This presupposes that there must be some original reinforcers from which other stimuli acquire their strengths (Skinner, 1953): These are called unconditioned or *primary* reinforcers. Thus, a primary reinforcer is a stimulus which has a reinforcing effect on operants without a history of learning. This function of stimuli has also been called susceptibility to reinforcement (Skinner, 1969) and has sometimes been suggested to be based in biological homeostasis systems (Glaser, 1971). What is a reinforcer for the behavior of one individual is not necessarily a reinforcer for someone else's behavior. Although primary reinforcers are almost always the same within a species, the strength of them likely varies by degrees in between individuals.

2.1.2 Procedural reinforcers

The word reinforcer typically refers to a stimulus with a reinforcing effect on the behavior for a specific organism. Sometimes reinforcer is used to denote a stimulus with the *procedural* role of reinforcing an operant, even when the actual reinforcing effectiveness of the stimulus is taken for granted (Cooper, Heron, & Heward, 2007). For instance, a food pellet is called a positive reinforcer in an experiment with rats, even when no formal test of reinforcing effects of food pellets on the behavior of all and every rat in the experiment has been carried out. Thus, in this context, "reinforcer" is used as a procedural term, with the actual effects only assumed (similar to the colloquial use of the word "reward"). In what follows, it will be evident from the context whether the term is used in the strict sense, or in a procedural sense.

2.1.3. Satiation and deprivation

The reinforcing strength of a stimulus varies, not only due to history of conditioning, but also with the current state of the organism. Deviations from homeostasis caused by deprivation and satiation, and potentially also by interactions with other stimuli, of the specific stimulus alter the strength momentarily, a phenomenon called motivating operations (Michael, 1993). For example, the reinforcing strength of water increases with duration of deprivation from water ("thirst" in lay language). Conversely, drinking many liters of water leads to

satiation, first making the water into a neutral stimulus, and eventually turning water into an aversive stimulus (Skinner, 1953). The same is true for most reinforcers: access to TV becomes more reinforcing after a long period of abstention, and too much TV makes access less reinforcing. However, stimuli such as alcohol, drugs, and social contact do seem to follow different rules, at least over longer stretches of time.

2.1.4. Automatic and socially mediated reinforcement

Some stimulation of the organism is produced directly by its behavior, irrespective of the context. For instance, the proprioceptive sensation of body-rocking is produced directly by the movement of the body (admittedly, in interaction with gravity). Some of such self-produced stimuli, for instance as in masturbation, function as reinforcers. It has been suggested that this kind of *automatic* reinforcement can maintain and explain many instances of stereotypic behaviors, such as those defining autism (Lovaas, Newsom, & Hickman, 1987). However, functional analyses of stereotypic behaviors often find them to be maintained by positive reinforcement in the form of social attention, or negative reinforcement in the sense of escaping aversive situations such as demand (certainly self-injurious behaviors; Cunningham & Schreibman, 2008). By contrast, reinforcers that are produced through the interaction with others can be called *socially mediated* reinforcers (Skinner, 1953). By necessity, reinforcers used in interventions are always socially mediated, because they must be controlled by the social environment and their presentation planned by the teachers.

2.2. Reinforcement in behavioral interventions

2.2.1. Uses

In behavioral interventions, reinforcers are used in three procedural ways. First, reinforcers are used to decrease the frequency of dysfunctional behaviors using differential reinforcement and non-contingent reinforcement procedures (Carr, Severtson, & Lepper, 2009), i.e reinforcing behaviors incompatible with a dysfunctional behavior. Second, reinforcers are used to increase the frequencies of already present socially functional behavior. This might entail keeping favorite items out of reach so that a child have to request them (Maurice, Green, & Foxx, 2001). Third, reinforcers in behavioral interventions are used to facilitate acquisition of completely novel skills such as communication, play, academic, social and daily living skills (Lovaas, 2003), such as in DTT. Although contrived reinforcers are used to establish these novel skills, only skills that eventually will be maintained by naturally occurring reinforcers are taught. For example, contrived reinforcers such as soap-bubbles may be used to teach a child vocalizations and pronunciation of specific phonemes. The use of these phonemes is then

maintained across settings and over time by the child using them to acquire attention or tangible reinforcers, such as asking for a favorite toy.

2.2.2. Examples

Examples of commonly used reinforcers in behavioral interventions with young children are hugs, soap-bubbles, candy, praise, tickling, riding a bus, shiny objects, watching youtube, or playing with a smartphone. For procedural reasons, the best reinforcers are those (aside from actually being strong reinforcers) that can be presented and consumed quickly following a correct response, and for which satiation is not immediate (Lovaas, 2003).

2.2.3. Reinforcement problems in interventions

Some common problems that arise in interventions, pertaining to reinforcement, should be mentioned. One problem is satiation. When a reinforcer has been used a lot, the strength of it typically decreases. This often happens when children have free access to the reinforcer during breaks or at home (Lovaas, 2003). Another problem is the use of assumed reinforcers which actually have no such function for the behavior of the child. Parents and teachers do not necessarily know what the child likes (Logan & Gast, 2001), and are particularly prone to overestimate social reinforcers such as praise (Anderson, Taras, & Cannon, 1996). To avoid these problems, several techniques for identifying powerful reinforcers have been developed, called reinforcer or preference assessments, outlined below.

2.3. Reinforcer Assessments Procedures

Procedures to identify effective reinforcers to use in interventions has been developed, and are described below. The two main groups are direct (experimental) and indirect (questionnaires) measures.

2.3.1. Direct measures.

Measures in which the behavior of a child, in relationship to different stimuli, is assessed can be called direct measures. Examples of this are single-stimulus presentations (Pace, Ivancic, Edwards, Iwata, & Page, 1985), in which the child is offered a stimulus (tangible), and percentage of trials that the child approach the stimulus is recorded. Alternatively, two stimuli are presented at the same time, as in paired stimulus procedures (Fisher et al., 1992). Either way, a hierarchy of stimuli is produced, averaged over several trials. A somewhat different technique is to offer the child an array of stimuli, typically arranged on a table. In this procedure, called a multiple stimulus presentation procedure (Windsor, Piché, & Locke, 1994), the percentage of presentation trials that stimuli were chosen is computed, and from this a hierarchy is created. An altered version of this procedure is including a removal rule. Chosen stimuli are

removed from the array after they have been chosen, so that eventually interest in all the stimuli can be assessed (DeLeon & Iwata, 1996). Direct measures are typically valid, in the sense that high-preference stimuli tend to be more effective as reinforcers than low-preference stimuli (Hagopian, Long, & Rush, 2004; Kang et al., 2013).

2.3.5. Questionnaires.

Very often, the first step is not a formal preference assessment, but simply letting adults who know the child well fill out standardized questionnaires. These typically consist of lists of stimuli that typically function as reinforcers for the behaviors of children or older individuals with developmental delays. Parents or teachers are asked to indicate which of these stimuli are most preferred by the child. One example is the Reinforcement Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996). Or the Reinforcement Survey Schedule (Cautela & Kastenbaum, 1967). These have been shown to reliably identify reinforcers (Cautela, 1972; Verschuur et al., 2011), although not consistently (Logan & Gast, 2001).

2.3.6. Hierarchies and range of reinforcers.

The preference or reinforcer assessments described above all aim to create *hierarchies* of potential reinforcers, identifying which are the most effective. This is only meaningful within an individual. However, in the words of Vollmer and Iwata (1991): “Reinforcement effects with a given stimulus often vary across individuals”. In other words, there is also a sense in which inter-individual comparisons are meaningful: the behavior of individual X is only reinforced by cookies and soap-bubbles, whereas the behavior of individual Y is reinforced by cookies, TV, music and attention. For the concept of reinforcement to be used to predict treatment outcomes, this kind of quantification of absolute number, or *range*, of reinforcers, is necessary.

2.4. Number of Reinforcers as a Predictor

2.4.1. Importance of using a range of reinforcers

With the aim to maximize the effectiveness of behavioral interventions, the role of variation in reinforcers has been investigated. Egel (1981) used a reversal design with three children with autism to compare the effect of varying reinforcers. During the two phases, either only one reinforcer (chosen from a list of known effective edible reinforcers) was used constantly, or three different reinforcers were used randomly. Children were then taught using typical DTT, and percentage correct responding and percentage of time spent on-task was recorded. Results clearly showed that varying the reinforcers led to more effective training. Similar results were obtained by Dunlap and Koegel (1980). One possible explanation of these

results is that varied reinforcers decrease the probability of satiation. In other words, varying reinforcers ensures that they all remain effective. In clinical settings, a large range of reinforcers means that there arise more situations in which the child is motivated to learn a new skill. This would be especially relevant for Incidental Teaching, which is reliant on spontaneous motivation in the child (Hart & Risley, 1982). A large reinforcer repertoire would also give more opportunities for generalization.

2.4.2. Inter-individual differences in reinforcers

As noted above, individuals differ in what functions as reinforcers for their behavior. This is both due to conditioning effects in their learning history, and perhaps due to genetic reasons (Vollmer & Iwata, 1991). More importantly, the range of reinforcers might differ: some children in behavioural interventions are easy to find reinforcers for, whereas others are hard to motivate. This can be described as differences in motivation, in curiosity, exploration drive, and so on.

2.4.3. Previous studies on motivation as predictor

As is evident from the above, the use of reinforcers is central in interventions based on ABA. Not surprisingly then, researchers have been interested in looking at motivation as a possible predictor of treatment outcome. An interesting early study by Sherer and Schreibman (2005) compared three children who had responded well in a PRT-program, to three children who did not respond. One of the discriminating factors between the two groups was "toy interest". Three more recent and larger studies should be noted, investigating the role of motivation (broadly defined), for the effectiveness of three different ABA-based intervention programs: PRT, ESDM and PECS. The first study, by Schreibman, Stahmer, Barlett, and Dufek (2009), used frequency of "toy contact" before intervention as a putative predictor of subsequent learning in both a DTT intervention, and PRT. Toy contact was found to predict response to PRT, but not DTT. A second study, by Vivanti, Dissanayake, Zierhut, and Rogers (2012) investigated the ESDM, and found that "functional object use" before treatment explained, on average across subscales, 30 % of treatment outcome as measured by Mullen IQ-tests. Finally, Yoder and Stone (2006) found that high "object exploration" predicted response to a PECS intervention. None of these studies investigated EIBI, although this is the most widely used intervention for children with autism.

3. Research question

Given the central theoretical role of reinforcers in behavioral interventions, can inter-individual differences in susceptibility to reinforcement be used to predict treatment outcome?

4. Summaries of papers

4.1. "Narrowing the Gap: Effects of Intervention on Developmental Trajectories in Autism".

To make way for our studies on using reinforcers as a predictor for treatment outcome, we first wanted to define an acceptable metric of treatment outcome. As noted above, most studies have used changes in standardized scores to quantify treatment outcome. This is problematic. First, it introduces random variation in data, due to the use of age norms. This might obscure actual regularities and make identification of predictors hard. Second, the purpose is to suggest an outcome predictor from within a behavior analytic framework. Change in standard score, typically understood as a latent trait variable, is not in line with a behavior analytic viewpoint. An outcome metric with less theoretical load, is preferable. Thus, in this first paper we utilize the outcome metric of learn rates. This is defined as the change of age equivalent in a test-score, divided by time between measurements, and was used in a previous outcome study by Howard et al. (2005). This is, in fact, a reinvention of an already existing metric, defined by Bagnato and Neisworth (1980) and by them called the Intervention Efficiency Index. We preferred to call this metric a "learn rate", as it is not necessarily linked to intervention effectiveness research, and because we felt learn rate to be more descriptive (note however, that in the next paper, this metric is called "rate of skill acquisition").

This new metric was applied to data from 16 published studies on outcomes in behavioral interventions for children with autism. Individual data for 453 children, previously collected by Eldevik for a meta study (Eldevik et al., 2009), was reanalyzed as learn rates, and graphed as developmental trajectories. Children were either considered to have received behavioral interventions, or to be in a control condition (receiving little or no behavioral intervention). The developmental trajectories before and during study periods were graphed, and clearly showed that children receiving behavioral intervention had steeper developmental trajectories than children in control conditions, both as measured with IQ-tests and parental questionnaires covering adaptive behaviors. In other words, they were increasing the size of their behavioral repertoire at a faster rate than children not receiving interventions. This conceptualization of development can be contrasted in the more traditional, change in standardized scores (exemplified in figure 3).

The paper demonstrates that learn rate is a useful metric to quantify treatment outcome, and replicates previous findings of large variation in treatment outcomes.

4.2. "Number and Controllability of Reinforcers as Predictors of Individual Outcome for Children with Autism Receiving Early and Intensive Behavioral Intervention".

It is well known that some children in interventions are easy to motivate: many stimuli functions as reinforcers for their behaviors (chocolate, music, videos, hugs, toys, etc). Other children exhibit less interest, and sometimes an intervention relies on just one or two reinforcers. Likewise, some children exhibit many stereotypic behaviors, often thought to be maintained by automatic reinforcers. This decreases the relative value of the socially mediated reinforcers that a teacher might use in intervention. In a sense, some children control their own reinforcers, and some children depend on their social surroundings to access their reinforcers. We hypothesized that it is this latter group that will benefit most from interventions. To test this idea, we constructed a two page questionnaire: the Socially Mediated and Automatic Reinforcers Questionnaire (SMARQ), which we gave to parents and teachers of 21 preschool aged children (mean age 3.5 years) who had completed 1 year of EIBI. We then counted the number of socially mediated reinforcers for each child, subtracted the number of stereotypic behaviors (automatic reinforcers), yielding one figure for each child. As it turns out, this number was correlated to the progress (learn rate, as computed in manuscript #1) children made during their year of intervention, explaining 50 % of the variation in outcomes.

However, this study has a few methodological limitations. First, the sample size is quite small, with only 21 participants. Second, it relies completely on adults reports, both for outcome (the Vineland), and for the quantification of number of reinforcers. Obviously, adults do not necessarily report reliably on reinforcers. However, unpublished validity checks on the SMARQ do indicate a high correspondence, 73 %, between parent reports and a formal test of reinforcer effectiveness (Klintwall, Talme, Kallenbäck, & Eikeseth, 2012). Also, previous studies investigating the validity of adult reports of reinforcing stimuli have reported acceptable correspondence with actual reinforcing properties (Cautela, 1972; Verschuur et al., 2011). Third, the study is retrospective, meaning that number of reinforcers was assessed after one year of treatment. This means that any correlation between treatment outcome and number of reinforcers might be due to that successful interventions entails expanding the number of reinforcers for the child. In other words, there is a risk that we measure the same thing twice. In fact, previous researchers have suggested (not unreasonably) that this is indeed one outcome of successful to treatment (Lovaas & Smith, 1989).

4.3. "Interest Level in 2-year-olds with ASD Predicts Rate of Verbal, Nonverbal, and Adaptive Skill Acquisition".

In this paper, the limitations of manuscript #2 were addressed and improved upon. The purpose, again, was to investigate whether a quantification of number of reinforcers could be used to predict treatment outcome for children with autism. However, this version of the study employed a prospective design, a much larger sample size (70 children instead of 21), and most importantly, a direct assessment of children's behavior in relationship to different stimuli, instead of relying on adult reports. The quantification of stereotypies was dropped, due to the problems with discriminating between stereotypic behaviors maintained by social reinforcers (attention) and those maintained by automatic reinforcers.

70 toddlers, mean age 1.8 years with ASD were recruited from a larger study. At Time 1, children were assessed using Vineland Adaptive Behavior Scales, the IQ-test Mullen Scales of Development (Mullen, 1995), and ADOS-T (Luyster et al., 2009). Between Time 1 and 2, children received interventions with a mean intensity of 13.9 hrs/week. ADOS recordings at Time 1 were coded using a new scoring system, the Interest Level Scoring for Autism (ILSA), focusing 10 stimuli in ADOS. Each stimulus was scored (based on emotion, initiatives, and curiosity) on a Likert-scale between 0 and 4, and a mean ILSA-score for each child was computed. At Time 2, a mean 16.3 months later, tests were repeated (and learn rates, here called "rate of skill acquisition" were computed). ILSA-score at Time 1 was entered into three separate linear regressions, with three dependent variables: rate of skill acquisition in VABS, verbal IQ, and non-verbal IQ. Other predictors were Time 1 ADOS-score, verbal and non-verbal IQ, and treatment intensity. ILSA significantly predicted acquisition rate of adaptive skills ($R^2 = .36$) as well as development of verbal mental age ($R^2 = .30$), above and beyond the effects of intake verbal and non-verbal mental ages and ADOS scores. ILSA-score also contributed ($R^2 = .30$), along with treatment intensity, to variance in development of non-verbal mental age. In the paper, reinforcers were analyzed as a mean "interest level" score. The alternative was to quantify number of stimuli that each child scored above 3 for, on the 4-point scale. This alternative scoring thus quantifies interest breadth rather than level, and a post-hoc analysis showed that this predicted outcome just as well as mean interest level.

4.4. "The Sparks that Light Up the World: Variation in Primary Reinforcers and the Development of Social Behaviors or Autism".

Given that range or strength of reinforcers seems to predict treatment outcome, perhaps this concept can be used to explain the development of autism itself?

In this paper, it is argued that autism is defined as lack or deficit in social behaviors. This lack in social behaviors persists over time, and, we argue, is the emergent effect of a lack of innate social motivation, cascading into lack of skills in a non-linear fashion. Specifically, we argue that this difference between typically developing and autistic children, presumably present at birth, lies in differences in primary reinforcers. There is evidence to suggest that some social stimuli (faces, voices, touch) are primary reinforcers, forming the basis for subsequent social behaviors. The behavior of some children is less reinforced by one or many of these primary social reinforcers, due to random genetic variation or because of de-novo mutations. These children will develop social behaviors at a slower rate, or not at all (as shown in the study in manuscript #1). Alternatively, there are other primary reinforcers, such as attending to repeating patterns, which are too reinforcing for these children, overriding social reinforcers and causing an autistic development. We argue that the behavior analytic concept of primary reinforcers might function as a bridge between behavior analysis and studies on the genetic and molecular basis of autism.

5. Discussion

5.1. Summary of Findings

5.1.1. Number of reinforcers is a good predictor

Using the novel outcome measure defined in manuscript #1, the learn rate (or rate of skill acquisition), it was demonstrated in two studies that the behavior analytic concept of reinforcer could be used to predict outcome for children with autism. The next study, manuscript #2, counted the total number of socially mediated and automatic reinforcers, by way of parental and teacher reports, and this predicted outcome in EIBI for children aged 2 to 5 years. Manuscript #3 describes as study replicating this finding, focusing socially mediated reinforcers only, with children aged 1 to 3 years, who received a larger range of different behavioral interventions. In this second study, a mean "interest level" score was computed, instead of a count of either/or reinforcers. In other words, a high score could represent a very high interest in a few reinforcers, or a more even interest in many reinforcers. A "reinforcer-count" analysis was conducted, and found to be almost identical to the analysis included in the paper. In either case, the second study also compared the reinforcer predictor to other, commonly suggested predictors, and was found to explain a larger proportion of the variance in outcomes. Indeed, as we argue in the fourth paper, the concept of reinforcement might be so

powerful as to actually be useful in explaining the etiology of why autism emerges in the first place.

5.1.2. Reinforcers can be reliably and quickly assessed

The studies described in manuscripts #2 and #3 demonstrate that number of reinforcers (or interest level) can be easily and reliably assessed. Both studies utilized preference or reinforcers assessments. The first paper utilized an indirect measure, a simple two-page questionnaire, to be filled out by parents and teachers. By combining data from two respondents per child, a conservative and hopefully more reliable estimate of reinforcers was achieved. This questionnaire approximation of reinforcers can realistically be used during a start-up phase of an intervention, to identify high-risk children (who score low). The second paper utilized a direct measure: already recorded ADOS-assessments, to which a simple scoring system, ILSA, was applied. The ILSA proved to be easy to master with minimum training, and still maintaining high reliability. Very likely, the ILSA can be used for real-time scoring of an ongoing ADOS-assessment, which is widely used in diagnostic procedures. Whether the ILSA is valid in the sense that a high score on an item predicts actual reinforcing properties of the stimuli remains to be investigated.

5.1.3. Limitations

The main limitations, in common for the above studies, should be noted. The studies all rely on outcome measures such as IQ and Vineland, which are consciously constructed to be stable measures, as opposed to measures of treatment outcomes. The studies above all describe children who received behavioral interventions, but knowledge about both intensity and details about the interventions is throughout limited. Finally, and perhaps most importantly, no actual reinforcer assessments were conducted, only approximations of interest level, based either on questionnaires or observations.

5.2. Findings Related to Previous Research

5.2.1. Compared to other predictors

Previous studies investigating motivation-type variables as predictors for outcome have used different measures when reporting results. One paper with results comparable to the studies described above is the study by Vivanti et al. (2012). As described above, functional use of objects explained, on average across sub-scales in Mullen, 30 % of the variance in outcome. Thus, this is very similar to the results reported in manuscript #3 above. However, the Vivanti (2012) study did not find any significant correlation with development in ADOS-scores. More importantly, the “functional object use” variable, used in this study, confounds

developmental level and motivation. Functional object use is not a valid approximation of range of reinforcers. The study on PRT described above (Yoder & Stone, 2006), using toy contact as the predictor of outcome, is more similar to the study in manuscript #3. This study found that toy contact, similar to a reinforcer assessment, predicted outcome in PRT. This predictor explained 24 % of the variance in outcome (Yoder, personal communication).

In the meta study described by Eldevik et al (2010), a model including the variables intake IQ, VABS, age and intensity explained 7 % of outcome in IQ, and 20 % of outcome in VABS. Compared to these predictors, the number of reinforcer predictors used in manuscripts #2 and #3 seem to be powerful indeed.

5.2.2. Etiology of autism

The results seem to lend support, in a roundabout way, to the Social Motivation Hypothesis of autism (Chevallier et al., 2012; Dawson, 2008). If interventions are more effective for children that are easy to motivate, for whom many socially mediated reinforcers are effective, already from ages as young as two years, this supports the idea of autism as a motivational disorder. For instance, the reinforcers used in interventions can be seen as substituting the lacking social motivation. It is not that children with autism cannot learn social skills such as language, perspective taking or pretend play, but rather that they lack the motivation to do so. When the motivation is ensured, as with the use of effective contrived reinforcers, these skills are established. Note however that many children with autism also are diagnosed with mental retardation, which, supposedly does indicate a general slowing down of learning. In this conceptualization, thus, mental retardation and autism are seen as two distinct diagnoses, although often comorbid. The techniques described in studies #2 and #3 could potentially be altered to be applied to younger children (during first year of life), and focused to test the reinforcing strength of social skills specifically. If such a social reinforcer assessment would also predict which children develop autism, this would lend more support to the theory presented in manuscript #4.

5.3. Clinical Implications

If reinforcer breadth or intensity predicts outcome in behavioral interventions, this could possibly be due to some underlying trait, explaining both interest level and treatment responsiveness. However, and more interestingly, reinforcer breadth could be a variable that can be manipulated, and which in turn would affect treatment outcomes. Some suggestions for how this could be done, the clinical implications of the reported findings, are outlined below.

5.3.1. Identifying more reinforcers

As described above, many techniques exist for identifying reinforcers (Kang et al., 2013), if only they are used throughout interventions and tested stimuli are tested creatively. For instance, the methodologically simplest preference assessment seems to be multiple-stimulus without replacement, which can easily be used with new stimuli. Typically, ideas for which stimuli to include in a reinforcer assessment come from observing the child during breaks and during free access to a large range of stimuli. Ideas can also come from reinforcer assessment questionnaires (such as the SMARQ or RAISD).

5.3.2. Play-focused interventions

Behavioral interventions focusing the development of play-skills (e.g. pretend play), has been shown to increase the diversity of play that children engage in. For example, a study by Kasari, Freeman and Paparella (2006), compared three groups with a total of 58 children (aged 3 to 4 years) who were randomized either to a control condition, a joint attention focused intervention, or an intervention focusing play-skills. Only the play-focused intervention increased diversity of play, measured as number of types of interactions with toys during a structured assessment, which might be an indication that more of the toys function as reinforcers after treatment. Similar results were recently reported by McDuffie, Lieberman and Yoder (2012).

5.3.3. Establishing more reinforcers through conditioning

The establishment of social stimuli such as smiles and praise as reinforcers has long been identified as a possible key intervention for children with autism (Lovaas et al., 1966). In most published manuals (e.g. Lovaas, 2003; Maurice, Green, & Luce, 1996), teachers a recommended to give students praise immediately *before* delivering tangible reinforcers, the rationale for which has been that classical conditioning will eventually establish praise as a reinforcer. However, because this often fails to happen (Lovaas et al., 1966), alternative techniques based on the discriminative-stimulus account of conditioned reinforcement are being developed and evaluations have shown promising results (Dozier, Iwata, Thomason-Sassi, Worsdell, & Wilson, 2012; Holth, Vandbakk, Finstad, Grønnerud, & Akselsen-Sørensen, 2009; Taylor-Santa, Sidener, Carr, & Reeve, 2014). These work by establishing the social stimulus as a discriminative stimulus (antecedent) for a response leading directly to an already powerful reinforcer. For instance, in Holth et al (2009), the teacher's smile was established as an antecedent for reaching behind a curtain and obtaining candy (candy was never available behind the curtain when the teacher was not smiling, ensuring discrimination). Techniques such

as these, developed primarily for social stimuli, are technically complicated, and have not been tested for long term effects of conditioning.

5.3.4. Example: Interventions for selective eaters

Perhaps a more clinically realistic example for expanding the repertoire of reinforcers comes from interventions for selective eaters. These interventions aim to increase the number of accepted foods, often vegetables and fruits. Three techniques are used: blending, operant conditioning and extinction of avoidance. In blending (Mueller, Piazza, Patel, Kelley, & Pruett, 2004), the non-preferred food (e.g. fruit) is mixed into a preferred food (e.g. ice-cream). Only a very small amount is added to the preferred food, so that the child still chooses to eat it. The proportion of non-preferred food is then gradually increased, but slowly so that the child continuously accepts the blend. The second technique is operant conditioning (Kern & Marder, 1996), in which, for example, touching, licking and taking bites of the non-preferred food is reinforced using, for example, a preferred food (although the reinforcer need not be another edible). Finally, acceptance of new foods can be achieved by extinction of avoidance behaviors (Gale, Eikeseth, & Rudrud, 2011). These techniques are obviously suitable for different types of foods and depending on why the child avoids novel foods. What's important is that following successful interventions, the non-preferred food typically becomes preferred, and can then be used to establish other non-preferred foods (Williams & Foxx, 2007).

5.3.5. Finding reinforcers as a treatment goal

Perhaps the most realistic technique for expanding number of reinforcers is something like reinforcer sampling. In this technique, contact with novel stimuli is reinforced, regardless of whether the child exhibits any interest in the stimulus. Familiarization with a new stimulus might reveal hitherto unknown enjoyment. Reinforcer sampling was first proposed for patients in psychiatric wards by Ayllon and Azrin in 1968, and has been used as part of behavioral activation for depression (Martell, Dimidjian, & Herman-Dunn, 2013). Surprisingly, reinforcer sampling has not been investigated as a formal part of early intervention, although it likely is used in clinical practice.

5.4. Future Research

5.4.1. Replication and expansion of findings

First of all, the two prediction studies described above need to be replicated to ensure their generalizability across age groups and types of behavioral interventions. The range of stimuli included in the reinforcer assessments need to be considered, to ensure that the whole range of possible reinforcers is included. For instance, smartphones are widely used as a

reinforcer in behavioral interventions, but this stimulus was not included in our studies. There are also methodological issues that future studies could improve upon, perhaps most notably by using a standardized assessment of range of reinforcers.

Although we argue in paper #4 that automatic reinforcers (stereotypic behaviors) might have a role in the development of some cases of autism, and this factor was also found to predict treatment outcome in paper #2, this was not included in paper #3. This possibility remains an avenue for future research. Other researchers have also suggested that too high-motivation for stereotypic behaviors might become a practical obstacle for acquiring social skills (Leekam, Prior, & Uljarevic, 2011). Similarly and interestingly, problem behaviors (tantrums, specifically) has been suggested to be a *positive* predictor of treatment outcome. The rationale for this is that the function of tantrums typically is access to preferred toys or attention, and the frequency of tantrums might thus, contra-intuitively, be an indication of a child with a high interest in many socially mediated reinforcers (Remington et al., 2007).

5.4.2. Reinforcer assessments

As noted above, the behavior analytic literature includes an impressive list of techniques for creating reinforcer hierarchies (Kang et al., 2013). This is useful for choosing which reinforcer is likely to be the most effective when working with a child. However, for the purpose of describing and quantifying the size of a child's reinforcer repertoire, other techniques are necessary. In the studies described above, the study in manuscript #2 utilized a questionnaire in which adults indicated whether stimuli either were or were not effective as reinforcers for a child. The study manuscript #3 investigated child behaviors directly (emotional, initiatives, and so on) in a semi-structured situation. However, a more valid and reliable quantification of a child's range of reinforcers can be achieved by using operant techniques. For instance, a set of stimuli (soap-bubbles, edibles, toys, and so on) can be tested for reinforcing qualities by testing what rate of responding, for some arbitrary response, they can maintain. Another alternative is identifying the different break-points under progressive ratio schedules for the same set of stimuli (Roane, 2008; Rollins, Loken, Savage, & Birch, 2014). However, both these alternatives appear time-consuming, and in the case of progressive ratio schedules, perhaps even unethical due to the extinction-like conditions these tests entail. This is specifically relevant as, due to the developmental nature of autism, future studies on etiology, even those with neurological methodologies, will likely focus toddlers and infants (Wolff & Piven, 2013).

5.4.3. Techniques for expanding number of reinforcers

One way forward seems to be conditioning techniques, attempting to establish more reinforcers using both classical and operant conditioning. This is a new field, and techniques

described in the literature (e.g. Dozier et al., 2012) are currently quite complicated. These would have to be simplified, adapted for use for more kinds of stimuli, and described in accessible manuals for applied use for a larger sample of children. Reinforcer sampling (Ayllon & Azrin, 1968) and play-focused interventions (Kasari et al., 2006) seem today to be the simplest and most realistic intervention to increase the number of reinforcers to use in interventions with children. However, these techniques have neither been evaluated for young children, nor over longer periods of time. Before conditioning techniques or reinforcer sampling can be recommended to be included in treatment curricula, studies have to investigate the long-term effects, if any, on treatment outcomes. Specifically, this should be tested for children for whom only a few reinforcers can be identified, such as those scoring low on the ILSA.

5.5 Conclusion

In the studies described above, the rate of acquiring social skills during treatments for children with autism was shown to be predicted by two different assessments of number of reinforcers (interest level). This predictor was then suggested to play a role in the development of autism per se. Some possible clinical implications of these findings are the need to further explore possible techniques for expanding the number of stimuli functioning as reinforcers for children starting in behavioral interventions.

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Appendix 1

SMARQ. Socially Mediated and Automatic Reinforcers Questionnaire

HØGSKOLEN I AKERSHUS
AKERSHUS UNIVERSITY COLLEGE ❑ Questionnaire / ❑ Interviewed by: _____ ID#:_____

Socially Mediated and Automatic Reinforcers Questionnaire (SMARQ)

English version 2011-06-05 (ABA)

Name of child (given name only): _____ Age: ____ years and ___ months. Girl: ❑ Boy: ❑

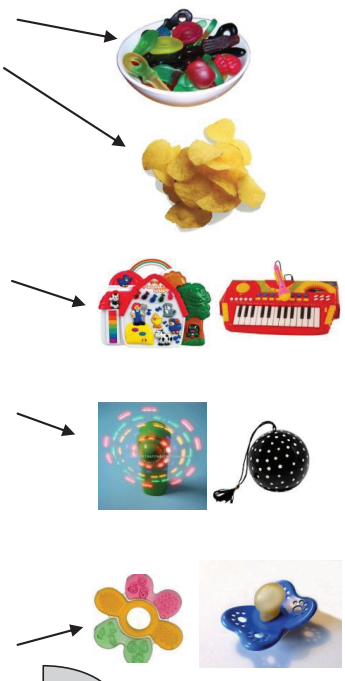
Your relationship to the child? (mother, therapist, etc):_____ Date: _____

A. External Motivation

- For every item in the following list, indicate whether this is something that the child likes to gain access to. This could mean that the child smiles, somehow asks for it, or tries to get hold of it if he or she knows where it is.
- If the child only *accepts* the item, for instance drinks milk but only when asked to, tick 'no'.
- If the child's preferences vary over the course of a day, give the answers thinking about what the child would be interested in during a normal morning before having lunch.
- Also indicate whether the item is something that is used as a reinforcer in the behavioral training, even if it is only used for a specific exercise.
- If uncertain, for instance if the child has no experience with an item, leave the squares empty.

#		**Does the child like this? yes / no**		**Is this used as a reinforcer in training? yes / no**	
1	Chocolate	❑	❑	❑	❑
2	Other sweet things such as candy, ice-cream or fudge	❑	❑	❑	❑
3	Fruits or berries, either fresh or dried, e.g. raisins	❑	❑	❑	❑
4	Salty snacks such as chips, cheese puffs, crackers	❑	❑	❑	❑
5	Most of the food served at the kindergarten	❑	❑	❑	❑
-	Other edibles: _____	❑	❑	❑	❑
6	Juice, lemonade, soft drinks	❑	❑	❑	❑
7	Water for drinking	❑	❑	❑	❑
8	Milk och other milk products	❑	❑	❑	❑
-	Other drinks:_____	❑	❑	❑	❑
9	Music: complete songs or jingles	❑	❑	❑	❑
10	Toys making sounds	❑	❑	❑	❑
-	Other sounds:_____	❑	❑	❑	❑
11	Dolls or lego (need not play appropriately)	❑	❑	❑	❑
12	Toy cars, trains or such	❑	❑	❑	❑
13	Cell phones, TV, DVD or YouTube	❑	❑	❑	❑
14	Visual toys that blink or flash	❑	❑	❑	❑
15	Pencils or crayons for drawing or writing	❑	❑	❑	❑
16	Soap bubbles (to blow oneself or watch others)	❑	❑	❑	❑
17	Hugs or cuddling (moves to the laps of adults)	❑	❑	❑	❑
18	To be tickled (indicates liking by initiating tickling)	❑	❑	❑	❑
19	Smiles or verbal praise (smiles when adults smiles)	❑	❑	❑	❑
20	To be chased by adults (runs, wanting to be chased)	❑	❑	❑	❑
21	To be thrown up into the air or spun by someone else	❑	❑	❑	❑
22	Social games such as pee-ka-bo or pairs	❑	❑	❑	❑
23	Pacifier or other things to chew or suck	❑	❑	❑	❑
-	Other:	❑	❑	❑	❑

Example:



Turn the page!

B. Behaviors without External Motivation

- Check 'yes' if the child has engaged in this behavior almost every hour of every day during the past week.
- If the behavior of the child varies significantly over the course of a day, give the answers thinking about what the child would be doing a normal morning if allowed to play freely.
- If uncertain whether the child engages in a certain behavior, leave the squares empty.

#		Yes	Seldom / never
1	Repetitively blinking, squinting or poking one's eyes	❑	❑
2	Spinning in a circle	❑	❑
3	Jumping up and down on the spot	❑	❑
4	Walking on toes	❑	❑
5	Biting or sucking one's hands or fingers	❑	❑
6	Flapping one's hands, excitement-induced or not	❑	❑
7	Shaking one's head from side to side	❑	❑
8	Looking at one's hands for longer than 10 seconds	❑	❑
9	Pressing on one's ears	❑	❑
10	Flicking one's ears or nose	❑	❑
11	Grinding one's teeth (whilst awake)	❑	❑
12	Breathing in particular rhythms	❑	❑
13	Humming, whistling or singing for oneself	❑	❑
14	Repeating a certain word or nonsense sound	❑	❑
15	Putting everything in one's mouth	❑	❑
16	Staring at particles in the air such as dust or sand sifted in front of one's eyes	❑	❑
17	Lining up objects into rows	❑	❑
18	Spinning or twirling objects or pieces of string	❑	❑
19	Feeling or tapping one's finger on surfaces	❑	❑
20	Using objects to tap surfaces (such as tapping a table with a pencil)	❑	❑
21	Repetitively switching lights or TV on and off	❑	❑
22	Repetitively opening and closing drawers or doors	❑	❑
23	Smelling oneself	❑	❑
-	Other behaviors that the child engages in a lot:		
-			

C. Additional Questions

For each of the statements listed below, indicate whether this is true for the child. If you are uncertain you don't need to mark any answer at all.

#		True	Not true
1	Tantrums at least once every day	❑	❑
2	Dislikes being touched and tries to resist hugs	❑	❑
3	Dislikes eye contact and refrains from it	❑	❑
4	Dislikes even moderate levels of noise, such as the buzz of a kindergarten	❑	❑
5	Dislikes food and eats nothing without being forced or tricked	❑	❑
6	Prefers to be alone, e.g. retires to a little corner on his or her own	❑	❑
7	Appears to be equally satisfied regardless of surroundings	❑	❑

Thank you!

D. How much time did you spend filling out this questionnaire? _____ minutes.
E. Please leave any comments or suggestions below, or mail them to lars.klintwall@hiak.no

_____
_____
_____

Appendix 2

ILSA. Interest Level Scoring for Autism

ILSA
Interest Level Scoring for Autism
Version 2013-06-01: ADOS

Child ID: ADOS date: ILSA-scorer:
Age: examiner:

ADOS assessment comments:

Parent comments about favorite toys / reinforcers:

Scoring guidelines

General

Score the level of interest the child exhibits for the different stimuli. Do not include parent comments in assessment. Any interest in the stimulus is scored, regardless if it is typical. However, interest which is not item-specific should be disregarded (such as mouthing everything). If several objects are included in the same category, score according to the object for which the child shows the most interest. Note that scoring criteria on different items are not identical, and that scores should not be expected to be even across items (e.g. edibles are likely more popular than books). Please circle/underline what criteria scoring for each item is based on and tally counts in available boxes. Try to follow indicated criteria, but clinical assessment takes precedence. At the presentation of the bubbles, indicate presence of RISB (see below).

Some definitions

Attends = For stimuli that requires that the adult activation or presentation (soap bubbles, spin-top etc), consider passive attending, i.e. looking at, the stimulus as an indication of interest.
Emotion = Smiling, laughing or excited hand-flapping. OR negative emotion when object is removed.
Never bores / forgets = At no point does the child forget about the stimulus or look away for more than 5 secs, unless offered another toy by an adult. Include initial ignoring of an offered stimulus.
Not tested = No opportunity given by examiner, or the child is too upset to even notice the stimulus.

The Likert-scale is *generally* ordered thusly

- ❑ **High interest**. Frequent attempts AND never gets bored.
- ❑ **Interest**. Frequent attempts OR emotion (positive or negative) OR constant attending.
- ❑ **Some interest**. Some attempts OR some attending.
- ❑ **Very little interest**. Some fleeting interest.
- ❑ **No interest**. Ignores.

ADOS: free-play stimuli (do not score later presentations)

Cause-effect toy (pop-up) (❑ Seeks out spontaneously or ❑ offered)

❑ 4. **High interest**. Frequent activations (≥ 10) AND never bores.
❑ 3. **Interest**. Frequent activations (≥ 10) OR emotion.
❑ 2. **Some interest**. Some activations (≥ 3).
❑ 1. **Very little interest**. Activates once or twice.
❑ 0. **No interest**. Ignores.

❑ **Not tested or impossible to assess.**

Toys that make sounds (key or telephone) (❑ Seeks out spontaneously or ❑ offered)

❑ 4. **High interest**. Frequent activations (≥ 10) AND never bores.
❑ 3. **Interest**. Frequent activations (≥ 10) OR emotion.
❑ 2. **Some interest**. Some activations (≥ 3).
❑ 1. **Very little interest**. A few activations (< 3).
❑ 0. **No interest**. Ignores.

❑ **Not tested or impossible to assess.**

Vehicles (truck, cars or airplane) (❑ Seeks out spontaneously or ❑ offered)

❑ 4. **High interest**. Seeks out, interacts extensively AND never bores.
❑ 3. **Interest**. Seeks out AND interacts extensively more than once.
❑ 2. **Some interest**. Interacts by exploring, driving, repairing or flying.
❑ 1. **Very little interest**. Picks up at some point, or load things into truck.
❑ 0. **No interest**. Ignores.

❑ **Not tested or impossible to assess.**

Shape-sorter (❑ Seeks out spontaneously or ❑ offered)

❑ 4. **High interest**. Sorts (≥ 10 blocks) AND never bores.
❑ 3. **Interest**. Sorts (≥ 10 blocks).
❑ 2. **Some interest**. Sorts or tries to sort (< 10)
❑ 1. **Very little interest**. Touches the blocks, but less than 2 sorting attempts.
❑ 0. **No interest**. Ignores.

❑ **Not tested or impossible to assess.**

ADOS: serial presentation (do not score interest during free play, e.g. for the doll)

Bubbles

❑ 4. **High interest**. Frequent requests (≥ 5) AND never bores of bubbles.
❑ 3. **Interest**. Frequent requests, (≥ 5), always attends when presented, OR emotion.
❑ 2. **Some interest**. Some requests (< 5) OR some attending OR touches.
❑ 1. **Very little interest**. Watches briefly.
❑ 0. **No interest**. Ignores.

❑ **Not tested or impossible to assess.**

Balloon (❑ rocket alternative used)

❑ 4. **High interest**. Frequent requests (≥ 5) AND never bores of the balloon.
❑ 3. **Interest**. Frequent requests (≥ 5), always attends when presented, OR emotion.
❑ 2. **Some interest**. Some requests (< 5) OR some attending OR touches.
❑ 1. **Very little interest**. Watches briefly.
❑ 0. **No interest**. Ignores.

❑ **Not tested or impossible to assess.**

Edibles (not juice)

❑ 4. **High interest**. Eats all that are offered AND never forgets about the snack before eating 10 pieces.
❑ 3. **Interest**. Requests OR eats all that are offered.
❑ 2. **Some interest**. Eats two pieces or more.
❑ 1. **Very little interest**. Tries one, may spit out.
❑ 0. **No interest**. Never tries any of the edibles.

❑ **Not tested or impossible to assess.**

Doll (score any interaction, i.e. touching, not necessarily pretend play)

❑ 4. **High interest**. Extended interaction AND never bores.
❑ 3. **Interest**. Extended interaction on several occasions OR emotion.
❑ 2. **Some interest**. Some interaction (e.g. carrying or pretend play).
❑ 1. **Very little interest**. Brief interaction, such as picks up or touches (< 3).
❑ 0. **No interest**. Ignores.

❑ **Not tested or impossible to assess.**

Remote controlled toy (bunny)

☐ 4. **High interest**. Frequent requests or activations (≥ 5) AND never bores.
☐ 3. **Interest**. Frequent requests / activations (≥ 5), always attends when activated, OR emotion.
☐ 2. **Some interest**. At least one request / activation OR touches (≥ 5) OR some attending
☐ 1. **Very little interest**. Watches or touches only briefly.
☐ 0. **No interest**. Ignores.

❑ **Not tested or impossible to assess.**

Peekaboo

❑ 4. **High interest**. Emotion AND attempts to repeat AND never bores.
❑ 3. **Interest**. Emotion AND attempts to repeat (pulling blanket over own head)
❑ 2. **Some interest**. Emotion OR attempts to repeat.
❑ 1. **Very little interest**. Eye-contact, but does not smile or laugh.
❑ 0. **No interest**. Ignores.

❑ **Not tested or impossible to assess.**