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Stimulus Control in Applied Work with Children with Autism Spectrum Disorder from the Signalling and the Strengthening Perspective

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Experimentally and theoretically oriented behaviour analysts have predominantly debated the usefulness of the 'response strength' concept. We analysed applied studies to open the discussion on the usefulness of 'response strength' versus an alternative view on understanding how the past controls current behaviour in applied contexts. This review examined five studies that focused on evaluating an intervention using stimulus control Applied Behaviour Analysis (ABA)-based techniques to teach skills to children with Autism Spectrum Disorder (ASD). The review aims to understand if behaviour change in applied studies is most straightforwardly understood as driven by the most recent past events or by likely future events extrapolated from more extended past patterns of events. The former is the basis of the concept of response strength. In the latter view, behaviour is exhaustively accounted for by identifying an extended pattern of events in the environment, which signals to the organism which behaviour will most likely produce a reinforcer. The findings of each study are analysed separately from both the signalling and the strengthening perspective. The results suggest that the signalling view provides a more comprehensive understanding of behaviour modification interventions in children with ASD. Implications for future research are also discussed.

Key words: Stimulus control, ASD, response strengthening, signalling

Individuals with Autism Spectrum Disorder (ASD) receive several therapeutic interventions that can significantly improve the quality of their lives. Among those, interventions based on Applied Behaviour Analysis (ABA) are commonly used and recommended by the American Academy of Paediatrics and the National Research Council (Hyman et al., 2020). An example of such intervention is teaching children socially significant behaviour or working on decreasing problem behaviour.

A significant number of studies, including long-term, large-scale ones, confirmed that children who receive over 25 hours of ABA therapy weekly for more than one year achieved a tremendous increase in their skills, with some children matching the developmental goals for their age (Eikeseth, 2009). The effectiveness of ABA techniques in interventions for children with ASD was validated in a meta-analysis (Virués-Ortega, 2010). It states that long term ABA interventions lead to "medium to large terms of intellectual functioning, language develop-

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ment, acquisition of daily living skills and social functioning in children with autism." (Virués-Ortega, 2010, p. 387).

The success of ABA interventions lies in establishing stimulus control. A stimulus serves as a cue signalling which behaviour needs to follow to produce a reinforcer. In this view, stimulus control is established when a child reliably discriminates, which response will lead to a currently significant event (a reinforcer). Virtually all behaviour analysts agree that behaviour depends on its ontogenetic and phylogenetic past. Our main task is to account for the ontogenetic past, that is, the learning history. Traditionally, most behaviour analysts agree implicitly that the past contributes to our current behaviour because the consequences of our past behaviour determine the strength of our current behaviour. Several behaviours of an organism's repertoire compete until the strongest behaviour wins and becomes observable. Palmer (2009) made this view explicit. This approach has served us well. However, at times it fails to explain the behaviour we are observing. On fixed-interval schedules, for example, the behaviour disappears right after the reinforcer is presented. This pattern is difficult to explain if reinforcers occurring contiguously with responses are assumed to produce the strongest behaviour. Another common observation is the reinstatement of extinguished behaviour happening when an event that used to function as a reinforcer for that behaviour is presented non-contingently, leading to what is commonly viewed as immediate restoration of behavioural strength. This phenomenon can be challenging in the case of an applied intervention aimed at discontinuing problem behaviour. Based on these observations, experimental and theoretical behaviour analysts have introduced a different perspective on understanding how our past contributes to our current behaviour. In this article, we will refer to it as the 'signalling perspective'.

In the signalling perspective, reinforcers on fixed-interval schedules are assumed to signal the organism to consume the reinforcer and not respond for a specific interval. When behaviour is reinstated due to what used to function as a reinforcer, this presentation is assumed to signal to the organism that reinforcers are available again. Accounting for these phenomena faces fewer problems from the signalling view than the strengthening view because we do not have to identity behaviour contiguous with reinforcers. In the signalling view, stimulus control is reinforcer control, whereby the concept of response strength become superfluous, which is a good thing considering the problems with this concept, which are elaborated upon, for example, in Cowie et al. (2019), Shahan (2017), and Simon et al. (2020).

Considering the nature of ASD, clinicians have to account for several issues, such as the difficulty to establish stimulus control (Borgen et al., 2017; Ingvarsson, 2016) that can take precedence during the intervention.

In the signalling view, changes in behaviour happen according to what is likely to occur next, as generalised from often extended past experience. Consequently, the behaviour comes under the control of correlations of events in the environment. The effect of the current significant event on behaviour depends predominantly on one's likely future as generalised from past experience and the current situation (Cowie, 2018). In the following, we will illustrate the signalling view with the help of an applied study by Jessel et al. (2016) and a basic scientific study by Krägeloh et al. (2005).

Jessel et al. (2016) examined transitions between different contexts (rich-rich, lean-lean, rich-lean, and lean-rich) in children with ASD. Not surprisingly, they observed that the transition to a lean context took the children significantly longer than the transition to a rich one. This phenomenon was observed in the first part of the study. The colour of the playmat the children were transitioning to matched the specific reinforcer density (green and yellow mats signalled rich reinforcement and blue and

red signalled lean reinforcement). For example, when asked to transition to the green mat, they would always have access to their preferred toy. When they were asked to transition to the blue mat, only the less preferred toy was available. In the second condition, the upcoming reinforcer density was unsignalled. This removed the differences in transition time. In that condition, the colours of the mats were not contingent upon the availability of certain toys as in the first condition, which removed predictability, i.e., the likely future could no longer be predicted from the past[1]. The colour of the playing mat would not affect the availability of preferred or less preferred toys. Consequently, when transitioning to a specific mat, the child could not know what toys would be available until they transitioned and the toy was presented to them.

These findings suggest that the availability of discriminative stimuli signalling the density of reinforcement waiting after the transition was responsible for the duration of transition and problem behaviour that accompanied it during shifts to the lean context. It was the likely future (toy they were going to as signalled by the mat colour) and not the immediate past (toy they were coming from) that controlled their behaviour (dawdling) when discriminative stimuli/signals(mat colours) were available. This difference in transition time disappeared when nothing was indicating events in the near future. This experiment illustrates that behaviour is controlled by what the next significant event (reinforcer) is likely to be, and not what behaviour has just been strengthened (i.e., if they had just played with the preferred toy or not). The central question is how extended the stimulus/reinforcement pattern in the environment is that controls behaviour. The strengthening view focuses on behaviour occurring directly before the reinforcer, while the signalling view focuses on more extended behaviour patterns and reinforcers.

In Krägeloh et al. (2005), pigeons were presented with two keys producing food pellets. Food was presented contingent on a pigeon having pecked on the other key most recently, i.e., it was contingent on switching pecking location. If the most recent behaviour had been strengthened, the pigeons would have pecked in the exact location again; however, the (more extended) pattern of availability of food contingent on not having been available in that location on the recent peck signalled the pigeons where food would be available next. Quickly learning this behavioural switching pattern makes sense from a phylogenetic perspective when organisms consume resources that deplete in a specific location after one act of consumption. Having consumed the resource will then signal that a switch of location will generate more of that resource, not staying where the behaviour was successful (i.e., reinforced).

In the following, we review five studies that evaluate an intervention using stimulus control ABA-based techniques to teach skills to children with ASD. We discuss their intervention effects from the signalling and the strengthening perspective.

Method

Literature search

The search was conducted in July, August, and October 2021 using the following online databases: Medline using EBSCO host and APA PsycInfo (including PubMed) using Ovid.

In each database, searches were conducted by inputting a search term related to diagnosis (i.e., *autism* or *ASD*) combined with *stimulus control* and *children* to form the following search query).

[1]Note that when we say "predicted", "extrapolated", "know", "experienced", and the like, we do not mean to imply that the organism engages in any activities in addition to its overt behaviour that we aim at explaining. The prediction, for example, *is* the behavior under stimulus control. Throughout this paper, "to predict the future from past experience" means solely that the organism's current behaviour is under control of past experiences and when the patterns in the environment in the past match those in the future, that behaviour will produce significant events ("reinforcers").

All abstracts returned during the electronic searches were reviewed to determine their suitability for inclusion.

Study Inclusion Criteria

The principal investigator screened titles and abstracts of the database searches and retrieved articles to determine eligibility. See Figure 1 for inclusion criteria.

Studies were included in this review based on the following criteria: each study (1) was an evaluation of intervention using stimulus control to teach a skill (2) implemented multiple baseline design across participants

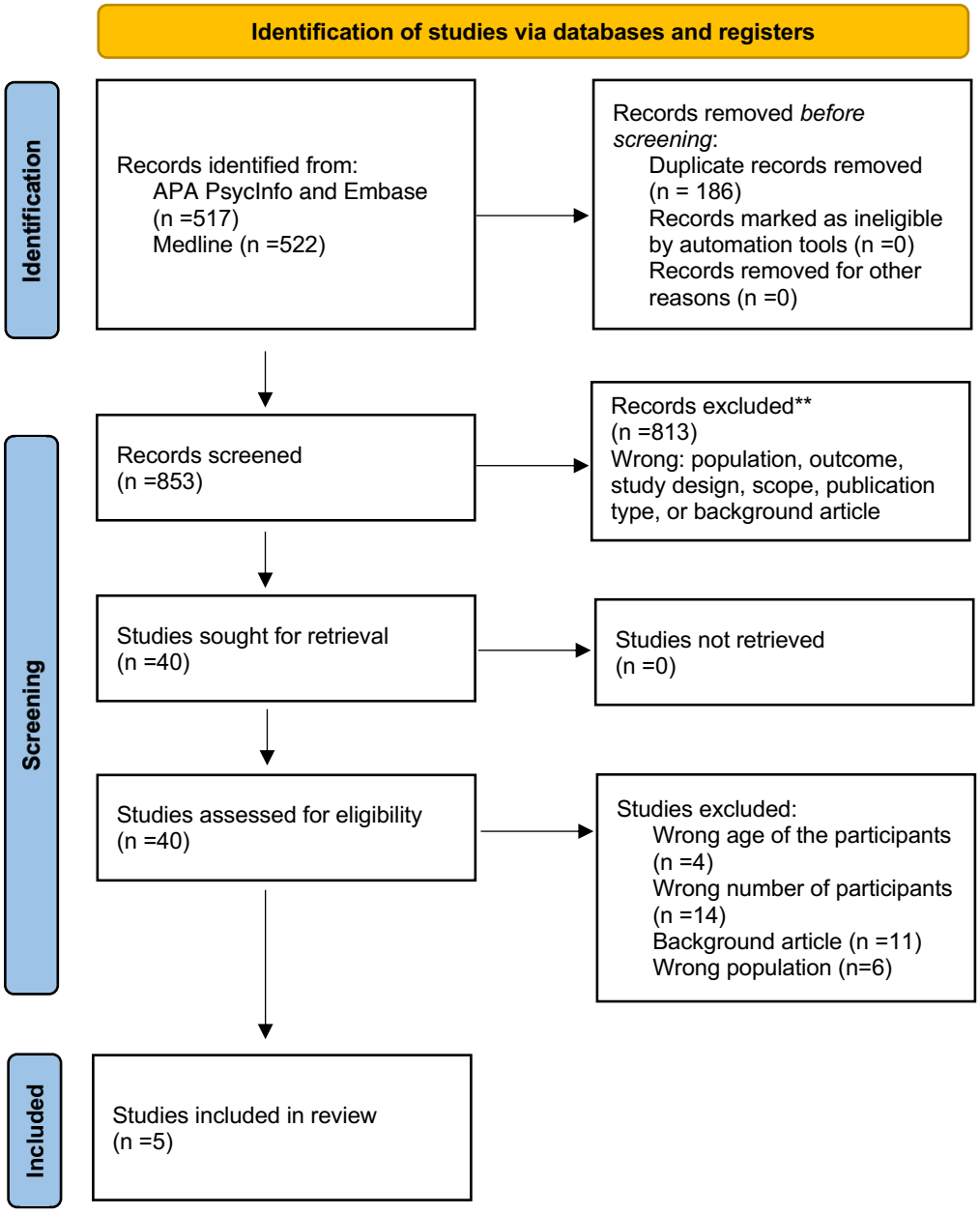

Figure 1. PRISMA 2020 Flowchart of the Study Selection Process.

(this design is particularly recommended to demonstrate that a significant behaviour change occurred as a result of the intervention, Hawinks et al., 2007), (3) had at least four participants aged 2-10 years old diagnosed with ASD (4) utilised observation to report data and (5) was reported in a peer-reviewed English language journal.

Studies were excluded when they described interventions that were not ABA-based or where the participants had additional diagnoses such as Attention Deficit Hyperactivity Disorder (ADHD) and other mental health disorders, and their data could not be disaggregated. For this review, we used the following definition of ABA techniques: ABA techniques are based on the "principles of behavior and are applied systematically to improve socially significant behavior, and experimentation is used to identify the variables responsible for behavior change" (Cooper et al., 2014 p. 2). Other criteria that disqualified research papers were when studies had isolated outcomes or the intensity/ duration standards of the intervention were not met. Additionally, articles that reported anecdotal records, monographs, master's theses, and literature reviews were excluded. All documents are available for others to crosscheck by contacting the first author. Data were collected on each study using a structured data sheet that included the reference: sampling size, age, gender, and diagnosis of included participants, setting, type of implementer, intervention type, experimental design, and whether measures of generalisation or maintenance were collected and the results of those conditions. Results of the studies were classified as positive, negative, or mixed based on the authors' determination.

Positive effects were noted when the authors indicated that the procedure was effective for all included participants. Negative results would have been shown if the authors stated that the intervention did not affect any of the participants included in the study. Mixed results would have been noted if the authors pointed out that the intervention was effective for some participants. No studies reported results from interventions that were disadvantageous for the participants.

Results

Table 1 provides an overview of data collected to evaluate interventions using stimulus control ABA-based techniques to teach a skill to children with ASD. Five studies met the inclusion criteria.

General Findings

The findings from this literature review are presented in Table 1. The current review studies included 22 total participants ranging in age from 2 to 8 years, all diagnosed with ASD. Classrooms in different settings (Day centre, Elementary Public School, Centre for children with developmental disabilities and Early intervention centre) were the context for intervention in 90% of the studies and researchers' office and home of the participant compromised of 10% of the studies. Therapists were the interventionists in three of the studies, followed by teachers in one research and researchers' and parents in the remaining study. Maintenance of treatment gains was not documented in any studies; however, generalisation measures were collected in 80% of the studies. Positive effects of the intervention were reported in 90% of the studies. Each paper reported different interventions, but all of them utilised stimulus control ABA-based techniques. Communication skills were targeted for intervention in 60% of the included studies; however, each focused on a different aspect. Ward et al. (2019) explored mand training using stimulus control procedure to encourage "acquisition and generalisation of mands for specific activities" induced by motivating operations (Ward et al. 2019, p. 215). Jones et al. (2014) surveyed social responses and generalisation in children with ASD when the recipients were either adults

Table 1. A Brief Overview of the Selected Studies.

Reference	Sample size	Age	Gender	Diagnosis	Setting	Type of implementer	Intervention type	Experimental type	Generalisation	Maintenance	Results
Borgen et al. (2017)	4	2 -3	1 F 3 M	ASD	Early Intervention program classroom	Therapists	Compliance with instructions by initiating the requested behaviour	Multiple baseline design across participants for Lucy and Patty with a brief return to baseline. Mixed schedule design with two different therapists for Charlie. ABAB design for Linus with a different therapist implements each baseline and treatment phase, followed by a please without reinforcement to comply with low-p instructions.	Stimuli but only for 2 participants	No	Positive

Table 1. Continued.

Reference	Sample size	Age	Gender	Diagnosis	Setting	Type of implementer	Intervention type	Experimental type	Generalisation	Maintenance	Results
Delemere et al. (2017)	6	2-7	1 F 5 M	ASD	Researchers' office and participant's homes	Researchers and parents	Bedtime fading and positive routines	Concurrent multiple baseline across subjects' designs were used to evaluate three independent variables on bedtime fading and positive routines.	No	No	Positive for bedtime fading and mixed for positive routines
Ingvarsson et al. (2016)	4	6-8	0 F 4 M	ASD	Center for children with developmental disabilities classroom	Therapists	Blocked trial procedure to establish complex stimulus control over intraverbal responses	Concurrent multiple probe design across question pairs was utilised to measure the effect of the blocked trial procedure on discriminated intraverbal responding.	No	No	Positive

Table 1. Continued.

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Reference	Sample size	Age	Gender	Diagnosis	Setting	Type of implementer	Intervention type	Experimental type	Generalisation	Maintenance	Results
Jones et al. (2014)	4	4-6	2 F 2 M	ASD	Day centre classroom	Therapists	Emitting target response during the activity	Concurrent multiple baseline design across participants was used to evaluate the effects of independent variables on the acquisition and generalisation of the targeted social responses.	Setting	No	Positive
Ward et al. (2019)	4	5-7	2 F 2 M	ASD	Elementary Public-School classroom	Teacher	Discrete trial training on a variety of verbal operant	Concurrent multiple baseline design across participants.	Setting	No	Positive

Note. F= female, M=male

or peers. Ingvarsson et al. (2016) studied the effectiveness of the blocked-trials procedure to establish complex stimulus control over intraverbal responses in children with ASD. Borgen et al. (2017) aimed to evaluate a procedure to establish compliance with instructions in children with ASD. Delemere et al. (2018) focused on positive routines and bedtime fading for sleep disorders in children with ASD.

Signalling versus Strengthening in the Studies

Three studies addressed establishing stimulus control in children with ASD. The first study (Ingvarsson et al., 2016) used a blocked trials procedure). The second study discussed establishing a novel therapist as a source of positive reinforcement (Borgen et al., 2017). The third utilised two procedures to increase appropriate sleep behaviours (Delemere et al., 2018).

Blocked-trials procedure to establish Complex Stimulus Control over Interverbal Responses in Children with Autism

According to Ingvarsson et al. (2016), the blocked-trial procedure effectively establishes stimulus control in children with ASD and increases intraverbal behaviour. In this procedure, participants were presented with a stimulus in separate trial blocks. The blocked trial procedure includes presenting sample stimuli in alternating blocks of trials. The size of the trial blocks is gradually reduced contingent upon correct responses until the order of presented stimuli is random. All of the participants mastered intraverbal discrimination using this procedure; however, some additional modification in the procedure was required for two participants. The order of the intraverbal probes was explicitly designed to enable researchers to assess the potential control exerted by multiple elements of the prior verbal stimuli.

Among several possible explanations why the blocked trials procedure yielded discriminated performance and increased participants' intraverbal behaviour is that repeated presentation of the auditory stimuli (a question asked by interventionists) can increase stimulus control (Ingvarsson et al. 2016).

When considering this phenomenon from the signalling perspective, which views behaviour as a pattern of activities extended in time (Baum, 2002), one can suggest that the success of this intervention relies on the reliability of verbal cues. In Ingvarsson's study (2016), a question asked by an interventionist (a verbal cue) signalled possible events in the near future, such as progression to the next step if the correct answers were provided. Hence, providing answers can be viewed as "extended behavioral allocations or activities" (Baum, 2002, p. 95). According to Baum (2002), a discriminative stimulus indicates that one activity offers more frequent reinforcement than another and increases the time one spends engaging in that activity. The same event can serve both as a discriminative stimulus and a reinforcer.

The results presented in this study add to the existing research, which suggests that behaviour depends on likely future reinforcers as generalised from past experience. Behaviour is driven by the prediction of the likely near future that allows the organism to fulfil the current dispositions based on its more extended history (Cowie, 2018). In Ingvarsson et al.'s (2016) study, we could observe this when participants' correct discrimination was based on their learning history with successfully established discriminative stimuli (a question asked by the interventionist) that signalled possible future reinforcers (descriptive praise offered by the interventionist after providing the correct answer).

From a perspective of strengthening, the results of this study (successful acquisition of multiple discriminations) would imply that the reinforcement provided for the last response (participants' last answer) resulted in the mastering of the particular discriminative skill. Ingvarsson et al. (2016) defined the mastery criterion as a child providing ten consecutive correct answers within

two sessions. Furthermore, we can observe that the overall pattern of responding (ten consecutive answers) enabled discrimination skill acquisition. Discriminative stimuli are viewed as events modifying the probability of a response. In this study, we consider them the context that sets an occasion for a response to occur. Verbal cues (questions asked) provided by the interventionist induced a response from the participant (an answer to a question asked). Participants' choice (providing an answer) was based on their extended past experience and discriminative stimulus (a question asked by an interventionist) available in the current situation.

A Method to Establish Stimulus Control and Compliance with Instructions

According to Borgen et al. (2017), a stimulus that had no previous history of exerting control over a particular (compliant) behaviour can gain the capacity to reliably prompt a response specified in an instruction. As Borgen et al. put it, for stimulus control to be successfully developed is for a "reinforceable response to reliably follow the presentation of the stimulus" (p. 831). It is also necessary that the probability of the reinforcers is higher in the presence of the stimulus than in its absence. The study aimed to evaluate a procedure to establish compliance with instructions in children with ASD.

Borgen et al.'s (2017) study consisted of three phases. The first phase was a baseline where the low probability of compliance instructions was delivered to the child at a minimum of 1-min intervals. Compliance with the instructions was reinforced, and non-compliance was ignored. It was followed by the compliance procedure to establish stimulus control, which consisted of ten steps followed in the same sequence across the participants. The researchers assumed that establishing stimulus control would be the easiest if the novel therapist was introduced since children would not have a history of non-compliance. The reinforcers were identified through preference assessment and were initially given to children on variable time 60s schedule, which continued for 6–8 minutes. Afterwards, an orienting cue was delivered when a child stopped the activity for 2–3 seconds. The cue was presented by saying a child's name in a very candid way that was novel and aimed at increasing the likelihood of orientation to the novel sound. Depending on an orienting response, the therapist handed over a piece of food (which served both as a discriminative stimulus and a reinforcer for compliant behaviour) from an approximately one-meter distance. When a child was approaching, they delivered the instruction to take it. The purpose of that procedure was to establish stimulus control of compliance with instructions. When correct responding to the instructions with a high probability of compliance was achieved (reliably responding to the name and taking food from a novel therapist), the researchers introduced low probability instructions, which consisted of higher demands and a leaner reinforcement schedule. The final phase was the parent training. The compliance scores in the baseline condition were low for all participants (below 20%); however, when a novel therapist was introduced in the treatment condition, scores were substantially improved (between 80%–95%), which suggested that when stimulus control was successfully developed (with the SD being a novel therapist delivering an instruction), participants produced a correct response based on their past experience (learning history with a novel therapist) and predicted events in the near future that instructions delivered by a novel therapist had signalled.

Addressing findings of this study from the strengthening perspective means to view behaviour as a result of reinforcement of the most recent response. However, the results reported by Borgen et al. (2017) suggest that the behaviour change occurred primarily due to the successful establishment of stimulus control, which was signalled by reliable orienting cues. Reinforcers did not strengthen the previous discrete response; instead, they

induced the pattern of behaviour (participants responded correctly to 3–8 high probability instructions and, thus, moved to the next phase of the study) that can be repeated in the future. Before introducing the low probability of compliance instructions (which were presented consecutively and the responding was scored as an overall pattern of responding to the sequence, not per response), researchers ensured that participants had an established experience of the high probability of compliance instructions. Hence, stimulus control over cooperative behaviour was instituted.

Parent Implemented Bedtime Fading and Positive Routines for Children with Autism Spectrum Disorder

Delemere et al.'s (2017) article explores two stimulus control-based interventions on total sleep duration, sleep onset latency and duration of night awakenings in children with ASD. It contained two settings. First, the participants' parents attended a brief training at the researcher's office, followed by parent-led intervention at participants' homes. Parents were asked to observe and measure their children's sleep behaviour each day and collect data using the sleep diary, both in the conditions of positive bedtime routines and bedtime fading. Positive bedtime routines consisted of a set of enjoyable and calming activities completed in a specific order to facilitate the sleep onset. Completion of each activity is praised, and transition to the next one commences. Routines move from rich to lean reinforcement, to establish appropriate sleep onset SDs by establishing behavioural chain terminating in behavioural quietude. Delemere et al. 2017 regarded sleep onset as the final reinforcer for completing this chain. Bedtime fading's central aim is to manipulate the sleep-wake cycle to increase the rapid sleep likelihood. The intervention requires temporarily moving bedtime to coincide with the child's natural sleep onset more closely. It allows immediate sleep initiation and then fading the intervention earlier if sleep onset latency remains short according to the developmental norms and parents' habits (Delemere et al., 2017). Before the intervention, the functional assessment interview was conducted to measure any environmental aspects contributing to sleep problems. The study was divided into a few phases, pre-baseline consisting of the meeting with the researcher and discussing the investigation. It was followed by the baseline phase, during which parents were asked to collect data on the current sleep routines and practise using an instruction sheet. In the intervention phase, 50% of the participants were assigned to the positive bedtime routines group and 50% to the bedtime fading group. Parents were implementing the prescribed activities and collecting data according to the sleep diary; each parent was collecting data individually. The study results suggest that parents implementing bedtime fading can yield successful outcomes in children with ASD; it increases the sleep duration and decreases the sleep onset latency for 100 % of participants.On the other hand, results obtained for the positive bedtime routines reported decreased sleep onset latency for all participants, but sleep duration increased only in two out of three participants. The parents positively rated both interventions. According to Delemere et al. (2017), when discussing stimulus control in the context of sleep, one should assume that for consistent sleep to take place, steps in the behavioural chain must come under stimulus control of appropriate discriminative stimuli. Considering those findings from a strengthening perspective would indicate that each discrete response emitted by a child and then reinforced by the parents facilitated the intervention's success. For example, in the bedtime fading condition, it would mean accomplishing sleep onset within the set target (below 15 min) or increasing total sleep duration by one hour and receiving positive social feedback immediately afterwards facilitated the results.

However, analysing the findings from the signalling perspective simplifies the

task, which is exceptionally well illustrated in the bedtime fading condition. The final aim of the intervention was an increase in total sleep duration, improvement of sleep onset latency and decrease in frequency and duration of night awakenings; hence the result of the intervention was based on the overall pattern of sleep behaviour and not on unitary responses. The overall length of positive bedtime routines is a continuous measure that does not translate well to discrete responses.

Assessing Stimulus Control and Promoting Generalisation via Video Modelling when Teaching Social Responses to Children with Autism

In their study, Jones et al. (2014) aimed to access stimulus control and promote the generalisation of social responses in children with ASD. The study consisted of baseline, training and generalisation probes. During the baseline condition, a therapist would provide a verbal prompt upon which a child had 10s to respond accordingly (by engaging in the social response); there were 10 trials in one session. If a child answered correctly, a reinforcer was delivered. The generalisation sessions were identical to the baseline ones, with the only exception being the interventionist (either another adult or a peer trained by the leading interventionist). The training phase consisted of a similar procedure as the baseline. However, in the training phase, the response time was shorter, a child had 5s to emit the response, and in case it did not respond, a verbal prompt was delivered. The generalisation of social responses across different adults and peers in Jones et al.'s (2014) illustrates the future-orientated nature of stimulus control. Children had previous experience with adult therapists before participating in the experiment; hence the presence of an adult versus peer in the trial signalled that reinforcers are possible to obtain. Participants' performance with different adults was identical during the initial generalisation probes and the training. The levels of responding with peers were substantially lower than those with adults. The presence of the peer per se or an absence of the adult in the trial controlled the participant's performance, hence served as a signpost of the possible future reinforcer as generalised from the past experience with the adults (children had previous experience rich in reinforcement with adult interventionists in the Center).

If learning (acquisition and generalisation of the social response) had occurred due to response strengthening, the change in behaviour (a successful generalisation of the acquired social skill) would have been caused by reinforcing the most recent response (the last produced social response), which could not explain why performance was different with peers than with adults. The procedure, materials, settings and reinforcers were identical in both conditions, with the only difference being the peer or adult. The presence of the adult signalled possible future events, and participants learned to behave accordingly. Jones' et al. (2014) participants had experience with adult interventionists, who had previously often delivered reinforcers in other contexts facility.

The Use of Stimulus Control Transfer Procedure to Teach Motivation-Controlled Mands to Children with Autism

The purpose of Ward et al.'s study (2019) was to explore if mand training utilising a stimulus control transfer procedure would help children to obtain and generalise mands for specific activities or objects induced by motivating operations Mands, especially motivating operations (MO) mands, are socially significant, similarly to the natural requesting behaviours observed in typically developed children (Ward et al., 2019). Mand is a verbal operant introduced by Skinner (1957) together with "tacts", "echoic" "intraverbals" etc. A mand is an utterance expressing a demand which a listener reinforces. MO manding is regarded as an advanced form of verbal behaviour. In MO manding, a motivation to gain access to a highly preferred item is present even when

the item is not visible or physically available to a child. When the child mands for this particular item, its behaviour is reinforced by a listener who grants access to the item. Ward's et al. procedure consisted of three phases: baseline, intervention, and generalisation. In the baseline, the participant's task was to mand for a visible item available at the table without a prompt; upon emitting the correct response, children were praised and received a reinforcer. During the intervention phase, highly preferred reinforcers were briefly shown to the participants and then hidden away. Upon responding correctly during the trial, the highly preferred item was made visible again without any prompt. If a child manded for it, a small amount of it (if it was an edible item) was immediately given to them. Afterwards, the highly preferred item was again removed from the participant's view, and the subsequent trial would begin. In the generalisation phase, participants' manding was accessed in the natural environment during classes or other naturally occurring school activities. Data were collected on whether they manded spontaneously for the trained or untrained targets. The results demonstrated that 90% of the participants used MO mands consistently after the skill acquisition. In the strengthening view, one member of a particular class of behaviour has to be followed by a member of another class, i.e., a member of the response class (producing a mand) is followed by a member of the reinforcer class (access to the requested item) and hence the response is strengthened and more likely to occur more often in the future (participant will mand more frequently in the future). However, the strengthening perspective does not serve the interpretation of the results well. The criterion to transition to the next phase of the study required a participant to demonstrate an increase in an overall acquisition of MO mands (50% higher than in the previous phase); hence the overall pattern of responding was the dependent measure. Furthermore, the overall results of the intervention were due to successfully established behaviour patterns (overall manding) extended in time instead of a discrete, momentary response (each mand). Ward and colleagues define the dependent variable as MO-controlled mands measured as time spent responding (manding), which had to occur within 15s upon presenting the highly preferable item. No discrete dependent variable enters the picture.

The successful skill acquisition and generalisation in three out of four participants were possible because of the use of multiple, repeated trials (in which a child would produce an unprompted request for a specific item). Through those repeated trials, participants built a learning history where a functional class of responses (correct manding) produced the reinforcers in the presence of MO (Ward et al., 2019). From the signalling perspective, participants' manding was controlled by their earlier pattern of responding (mands emitted in the previous trials) and the verbal cues/3s presentation of the possible reinforcer available in the current environment.

Discussion

Overall Comments

The current literature contains a variety of ABA-based interventions to teach skills or reduce problem behaviour and increase compliance in children with ASD. All aim at understanding how the past contributes to current behaviour. Here we presented two approaches to answer this question, the traditional strengthening view and the more recently introduced signalling perspective. We showed how the success of several interventions ranging from increasing communication repertoire to compliance and sleep behaviours could be straightforwardly interpreted from a signalling perspective, avoiding the pitfalls of the concept of behavioural strength as discussed at length by Simon et al. (2020). The overall conclusion of this review is that it was the successfully established stimulus control in various forms across the studies (a verbal cue in Ingvarsson,

2016; Ward, 2019, a novel therapist in Borgen, 2017, or a presence of an adult in Jones, 2014) that perpetuated the behaviour change based on the extended past experience (relation between reinforcers and overall pattern of responding) in those interventions. The results of the interventions mentioned above cannot be accounted for smoothly with a focus on strengthening of the most recent responses.

Limitations

Inclusion criteria present a possible limitation of the study. The current review only surveyed articles that were published in English language peer-reviewed journals. Our specific inclusion criteria may have excluded several studies such as 'grey' literature (thesis, dissertation monographs, etc.). Moreover, studies needed to include at least 4 participants diagnosed with ASD, aged 2–10 years old. In hindsight, this particular inclusion criterium may have been too stringent and may have contributed to the relatively low number of studies included in the review.

Future Research

In this review, several interventions utilising stimulus control ABA-based techniques were effective, such as those aiming to expand communication repertoire (Ingvarsson, 2016; Jones et al., 2014; Ward, 2007) or increase compliance (Borgen et al., 2017) in children with ASD. It would be advantageous for basic and applied behaviour analysis if more studies were conducted explicitly from the signalling and the strengthening perspective. The signalling perspective takes a molar view on behaviour, which is unknown to many applied researchers. Designing applied studies from a molar perspective would be a unique opportunity for collaboration between clinicians implementing ABA interventions for children with ASD and researchers from basic and applied research fields whose interests lie in molar behaviourism. Molar behaviourism is an alternative to radical behaviourism, focusing on how behaviour comes under the control of correlations of events in the environment.

Conclusion

In the current review, five studies were examined. All of the studies reported overall positive results. The interpretation of these studies from the two alternative perspectives sheds additional light and adds value to the obtained outcomes. However, in our opinion, the majority of these results are more straightforwardly understood from a signalling perspective than a strengthening perspective, especially when taking into account the pitfalls of the concept of response strength elaborated upon elsewhere (Cowie et al., 2019); Shahan, 2017); Simon et al., 2020).

Our analysis carries the potential to inform basic scientists about the practical relevance of their research and aims at inviting colleagues working on applied studies to broaden the conceptual basis of their work. They may significantly improve their interventions' effectiveness and theoretical consistency by designing them from the signalling perspective.

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