J Dev Phys Disabil
DOI 10.1007/s10882-016-9506-0

REVIEW ARTICLE

Behavioral Indicators of Satiation: a Systematic Review

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Abstract The use of behavioral indicators as a measure of satiation was a procedure developed by O'Reilly et al. (*Journal of Applied Behavior Analysis*, *32*, 371–374, 2009) to systematically manipulate presession access to a tangible reinforcer. In order to gain a better understanding of the utility of behavioral indicators of satiation in applied settings, a systematic literature review was conducted identifying nine additional studies that implemented this procedure. This review synthesized the research in terms of participant characteristics, use of behavioral indicators, dependent variables, and study outcomes. Results suggest this procedure is an effective way to decrease challenging behaviors and increase adaptive, on-task behaviors, adding to the literature in regard to the manipulation of abolishing operations as well as serving to identify future investigations into the use of behavioral indicators as a measure of satiation.

Keywords Satiation · Abolishing operations · Behavioral indicators

Motivating operations (MO) are variables that influence the momentary effectiveness of a reinforcer as well as the probability of behaviors occurring previously associated with that reinforcer (Langthorne and McGill 2009; Laraway et al. 2003). Establishing operation (EO) are MOs that increase the effectiveness of a stimulus and have an evocative effect, or increase in the current frequency of a behavior previously reinforced with that stimulus. Abolishing operations (AO) have the opposite effect given there is a decrease associated with the effectiveness of a stimulus and an abative effect, or decrease in the current frequency of a behavior previously reinforced with that stimulus. The benefits of manipulating MOs have been demonstrated across the literature, particularly with individuals with developmental disabilities. Predominately studies examining MOs with this population have aimed to decrease challenging behaviors of varying topographies, including aggression (e.g., Kahng et al. 2000),

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Published online: 26 August 2016

rumination (Thibadeau et al. 1999), stereotypy (e.g., Rapp 2004) and others. Moreover, researchers have taught or increased adaptive skills such as communication (e.g., Howlett et al. 2011) and functional play (Lang et al. 2009; Lang et al. 2010).

Typically, MO interventions designed to reduce challenging behavior and/or increase adaptive behaviors do so by altering states of deprivation and satiation with the reinforcing stimulus, either with presession access (i.e., satiation) or without presession access (i.e., deprivation) to preferred items, stereotypy, or attention (e.g., Fragale et al. 2012; Lang et al. 2010; Rispoli et al. 2014). Because of the utility in changing the reinforcing value of a stimulus and either abating or eliciting behaviors associated with it, the manipulation of both EO and AO has become more widely used in applied settings. In addition, MO interventions are antecedent manipulations with the potential to prevent the occurrence of challenging behaviors as well as influence multiple behaviors, which may be an added benefit for utilizing MO interventions when identifying and selecting treatment packages in applied settings (Laraway et al. 2003). Both EO and AO intervention procedures have been widely researched. However, just two methods have been utilized for AO intervention procedures with a preferred stimulus: timed presession access and behavioral indicators of satiation.

Perhaps the earliest record of AO manipulations (Gewirtz and Baer 1958) as well as the most widely utilized by researchers and clinicians throughout the literature is timed presession access, which allows for an arbitrarily predetermined duration of access to a stimulus. Timed presession access conditions have addressed a variety of challenging behaviors such as aggression and stereotypy (Chung and Cannella-Malone 2010) as well as adaptive skills like labeling colors (Cengher et al. 2014). Typically, an amount of time was set aside prior to a teaching session to allow the participant access to a preferred item or activity. However, across the literature the duration of access to a reinforcer varied greatly, with timed sessions ranging from several minutes up to 1 h (Kuhn et al. 2009; O'Reilly 1999). Given the variability in its implementation, this procedure was unsystematic for reasons related to individual differences. For example, access to a reinforcer for 10 min may be enough access to have an abative effect on challenging behavior for one individual, yet for a different individual 10 min of access could have an evocative effect on challenging behavior as the condition acted as an EO rather than an AO.

For this reason, an alternative method of identifying satiation, or habituation, was developed. Researchers identified response topographies used by participants to reject a tangible stimulus through parent and teacher report and empirically verified these through an item rejection analysis (O'Reilly et al. 2009). An item rejection response topography included dropping the item on the floor for one participant or holding the item in the nondominant hand while manipulating other items in the dominant hand for the second participant. Following this report and analysis both participants were exposed to three presession conditions: no access, brief access, or satiation. In the no access condition the participant had no previous access to the preferred item for at least 8 h prior to the session, while in brief access the participant was allowed 5 min of access to the preferred item. In the satiation condition the participant was given continuous access to the preferred item until the identified item rejection behavior occurred three times (e.g., dropping the preferred item on the floor). Following each presession period, a tangible condition of the functional analysis was conducted.

Results demonstrated that challenging behavior was highest in the brief access condition, wherein it was hypothesized that this condition acted as an EO. Challenging behavior was lowest in the satiation condition, wherein it was hypothesized that this condition acted as an AO.

Several studies have replicated these procedures demonstrating the utility of behavioral indicators of satiation across response topographies and functions of challenging behavior. For example, Rispoli et al. (2014) utilized the procedures by O'Reilly et al. (2009) and found stereotypy was lowest and academic engagement was highest following the display of three item rejection behaviors in the satiation condition. Similarly, Lang et al. (2010) found functional play skills were higher for participants during intervention sessions following the AO condition in addition to a relative reduction in levels of stereotypy and challenging behavior. From this, it is evident researchers have been able to successfully replicate the behavioral indicators of satiation procedure and expand its application.

In order to gain a better understanding of the use of behavioral indicators of satiation in applied settings, a systematic literature review was needed to analyze studies employing this procedure. The purpose of this review was to synthesize research on behavioral indicators of satiation in terms of participant characteristics, use of behavioral indicators, dependent variables, and study outcomes to add to the literature on the manipulation of AOs and also serve as a starting point for further investigation into additional applications of behavioral indicators of satiation.

Method

This review consisted of a systematic search and analysis of studies that utilized behavioral indicators as a measure of satiation. The results of the analysis are summarized in the following categories: (a) participant characteristics, (b) use of behavioral indicators, (c) dependent variables, and (d) study outcomes. Due to the relatively recent development of procedures to identify and utilize behavioral indicators of satiation in the literature, the intent of this review was to include all published studies.

Search Procedures

A systematic search was conducted in the following databases: Education Research Complete, Educational Resources Information Clearing House (ERIC), MEDLINE, PsycARTICLES, PsycINFO, and Psychological and Behavioral Sciences Collection. On all the databases the following free-text terms were entered utilizing Boolean operators and truncation: *abolishing operation, establishing operation, motivating operation, habituation, presession access, rejection behavior,* and *satiation* paired with *autism, cognitive disability, developmental disability, disability, intellectual disability, mental retardation, neurotypical, pervasive developmental disorder,* and *typically developing*. The abstracts of the resulting articles were reviewed and compared against inclusion and exclusion criteria to identify potential studies for inclusion. A total of 10 articles were identified using the electronic database search.

With this completed, two more search methods were then employed to locate additional relevant articles. The first method consisted of a hand search of all 2013

and 2014 volumes of the following journals: *Journal of Applied Behavior Analysis, Behavior Modification, Behavioral Interventions,* and *Research in Autism Spectrum Disorders* as these journals published the majority of studies included in this review. No additional studies meeting inclusion criteria were located in these journals. The second approach to finding other studies for this review consisted of an ancestry search of references from the articles identified for inclusion by the previous search methods. No studies were found meeting inclusion criteria from this search method either.

Inclusion and Exclusion Criteria

To be included in this review three criteria were specified including (a) studies used behavioral indicators to determine satiation, (b) studies described using a procedure to identify participant behaviors that acted as an observable indicator of stimulus rejection, and (c) each study had to be published in English in a peer-reviewed journal after 2008. This final criterion was included as O'Reilly and colleagues (2009) were the first to publish procedures to systematically analyze reinforcer rejection behaviors and use behavioral indicators during presession access as a way of manipulating MOs.

Data Extraction

Each study was assessed against the inclusion criteria and data were extracted on (a) participant characteristics, (b) use of behavioral indicators of satiation, (c) dependent variables, and (d) study outcomes. Participant characteristics were coded according to gender, age, diagnosis, and function maintaining challenging behavior. Use of behavioral indicators coding consisted of the research design employed, the individual carrying out procedures and the setting where procedures took place. Each article was also coded as to the number of reinforcer rejection behaviors utilized as a measure of satiation and the mean latency to satiation. Furthermore, this encompassed the reporting of interobserver agreement, treatment fidelity, and social validity. Dependent variables were coded according to type (e.g., challenging behavior, communication). Study outcomes were coded as having an (a) abative effect, or (b) evocative effect on targeted dependent variables. Accordingly, the studies were coded as having an abative effect if participants demonstrated reductions in dependent variables. Studies were coded as having an evocative effect if participants demonstrated an increase in dependent variables.

Inter-Rater Agreement

A total of 14 items per study were summarized based on these categories by the first author. Two advanced graduate students specializing in applied behavior analysis were trained in data extraction methods by jointly summarizing one article. These individuals then independently summarized three studies each for a total of six studies (60 %) to assess the reliability of data extraction. There were 140 items in which there could be agreement or disagreement (i.e., 10 studies with 14 items per study). After the reliability coding of studies was completed, agreement for the summarized items was determined as 87 %. All disagreements were discussed until consensus for coding was reached.

Results

Of the 10 studies meeting inclusion criteria, each employed a single case multielement research design. To summarize these studies Table 1 outlines pertinent information in terms of participant characteristics, use of behavioral indicators, dependent variables, and study outcomes related to the satiation condition only.

Participants

A total of 24 children, ranging in age from 4-years-old to 12-years-old participated in these research studies. Gender was identified for all participants with 33 % (n = 8) being female and 67 % (n = 16) being male. All participants were diagnosed with

Table 1 Studies using behavioral indicators of satiation

Authors	N	Disability	Rejection Behavior(s)	Target Behavior(s)	Study Outcomes
Davis et al. (2014)	1	ASD, ID	3	Challenging behavior	Abative effect on challenging behavior
Fragale et al. (2012)	3	ASD	3	Communication	Abative effect on communication
Lang et al. (2009)	1	ASD	1	Challenging behavior; Stereotypy; functional play	Abative effect on challenging behavior and stereotypy; evocative effect on play
Lang et al. (2010)	4	ASD	1	Challenging behavior; Stereotypy; functional play	*Abative effect on challenging behavior and stereotypy; evocative effect on play
Neely et al. (2015)	2	ASD; ID	3	Stereotypy; academic engagement	Abative effect on stereotypy; evocative effect on academic engagement
O'Reilly et al. (2012)	3	ASD	3	Communication	Abative effect on communication
O'Reilly et al. (2009)	2	ASD	3	Challenging behavior	Abative effect on challenging behavior
Rispoli et al. (2011a)	2	ASD	3	Challenging behavior; academic engagement	Abative effect on challenging behavior; evocative effect on academic engagement
Rispoli et al. (2014)	3	ASD, ID, Seizure	3	Stereotypy; academic engagement	Abative effect on stereotypy; evocative effect on academic engagement
Rispoli et al. (2011b)	3	ASD, CS HY, CO	3	Challenging behavior; academic engagement	Abative effect on challenging behavior; evocative effect on academic engagement

ASD autism spectrum disorder, *ID* intellectual disability, *CS* congenital scoliosis, *HY* hypotonia, *CO* chronic otitis media

* Denotes mixed effects on study outcomes

autism spectrum disorder (ASD) of which 12.5 % ($n = 3$) had an additional diagnosis of intellectual disability. Furthermore, 4 % ($n = 1$) of all participants had an additional diagnosis of seizure disorder, 4 % (n = 1) had hypotonia, 4 % (n = 1) had chronic otitis media, and 4 % (n = 1) had congenital scoliosis. All participants were reported as attending school and receiving special education services.

Of the 10 studies included in this review, 80 % ($n = 8$) reported the use of a functional behavior assessment to determine the function of participants' challenging behavior. In 70 % of included studies an analogue functional analysis was conducted in the manner of Iwata, Dorsey, Slifer, Bauman, and Richman (Iwata et al. 1994). Of these seven studies, 57 % ($n = 4$; Davis et al. 2014; O'Reilly et al. 2009; Rispoli et al. 2011a; b) determined the participants' function of challenging behavior was access to tangibles. In 43 % of these studies ($n = 3$; Lang et al. 2010; Neely et al. 2015; Rispoli et al. 2014), the functional analysis found the behavior of the participants' stereotypy to be automatically maintained. In another 10 % of the total studies ($n = 1$; Lang et al. 2010) an indirect functional assessment using the *Questions About Behavioral Functions Scale* (Paclawskyj et al. 2001) was conducted, which hypothesized that stereotypy was automatically maintained.

Finally, in 20 % of all included studies ($n = 2$; Fragale et al. 2012) the function was not addressed as neither challenging behavior nor stereotypy was measured, but rather both studies solely addressed communication skills.

Behavioral Indicator Procedures

Implementer and Setting Each of the 10 studies included in this review reported the individual responsible for implementing the research procedures. In 60 % ($n = 6$) of studies the experimenter was identified as carrying out the various conditions. In 40 % ($n = 4$) of studies the trainer was designated as a therapist who were graduate students specializing in behavior analysis or special education.

The setting of each experiment varied both across and within studies. In 50 % ($n = 5$) of studies sessions were conducted within the participants' classrooms at school. In 29 % ($n = 4$) of studies sessions were conducted outside of the classroom, but within the school building. These settings included the cafeteria, an individual instruction room, or the resource room. In 14 % ($n = 2$) of studies sessions took place in a clinic affiliated with a university. Finally, 7 % ($n = 1$) of studies held sessions in the participant's home.

Item Rejection Behavior Each article included in this review cited the methodology as outlined by O'Reilly et al. (2009) as being used to determine item rejection behavior and subsequent satiation with a preferred stimulus. These procedures were systematic in application across studies and included few variations from the original procedures. The only difference noted was that 80 % ($n = 8$) of studies used three item rejection behaviors as a measure of satiation whereas 20 % ($n = 2$) of studies used one item rejection behavior to indicate satiation.

Of further note was that 80 % of all studies included in this review reported the mean latency to the third item rejection behavior. This ranged widely from 5 min 40 s to 45 min in total. No study reported the individual latency to the first, second, or third item rejection behaviors or total duration of the abative effect. The topographies of item

rejection behaviors were distinctly different across participants (e.g., putting the item down, getting off the trampoline, saying "no").

Interobserver Agreement Interobserver agreement was reported across all articles included in this review. Each of the 10 studies reported agreement as exceeding 80 % for functional analyses, presession access conditions, and other dependent variables relevant to the particular study. However, interobserver agreement for item rejection analyses was only reported explicitly in two studies whereas it was combined across conditions in all others. Interobserver agreement for item rejection analyses ranged from 96 % to 100 % agreement.

Treatment Fidelity Treatment fidelity was reported in 40 % (n = 4) of articles. For three studies treatment fidelity was reported ranging from 95 % to 100 % across all participants for all conditions. For one study treatment fidelity was reported as 100 % for the implementation of presession conditions and as exceeding 88 % for all participants during the intervention phase of the study.

Social Validity No study included in this review assessed the social validity associated with the use of behavioral indicators of satiation, presession access to a preferred reinforcer, or other interventions included as part of the research procedures.

Dependent Variables

There were five different behaviors targeted for intervention across studies. The most commonly reported dependent variable for 54 % (n = 13) of participants was challenging behavior (e.g., screaming, aggression). The second most frequent focus of behavior change was stereotypy in 42 % (n = 10) of participants. Academic engagement was targeted for improvement in 42 % (n = 10) of participants. Communication was measured in 21 % (n = 5) of participants to determine improvements in manding for tangibles. Finally, functional play skills were addressed in 21 % (n = 5) of participants. Figure 1 compares the dependent variables investigated in each of the 10 studies in the satiation condition only in terms of abative and evocative effects per participant.

Study Outcomes

All studies demonstrated MO effects on behavior following the satiation condition. In the 80 % (n = 8) of studies measuring challenging behavior and/or stereotypy there was an abative effect following the use of behavioral indicators of satiation. On the other hand, in the 60 % (n = 6) of studies that reported evocative effects participants demonstrated increases in academic engagement and/or functional play skills following the satiation condition. In these studies, presession access until the demonstration of the behavioral indicator of satiation had an abative effect on challenging behavior while simultaneously having an evocative effect on academic engagement or functional play skills (e.g., Lang et al. 2009; Rispoli et al. 2014).

Furthermore, in the 20 % (n = 2) of studies measuring communication skills there was an abative effect following the display of three item rejection behaviors. This was

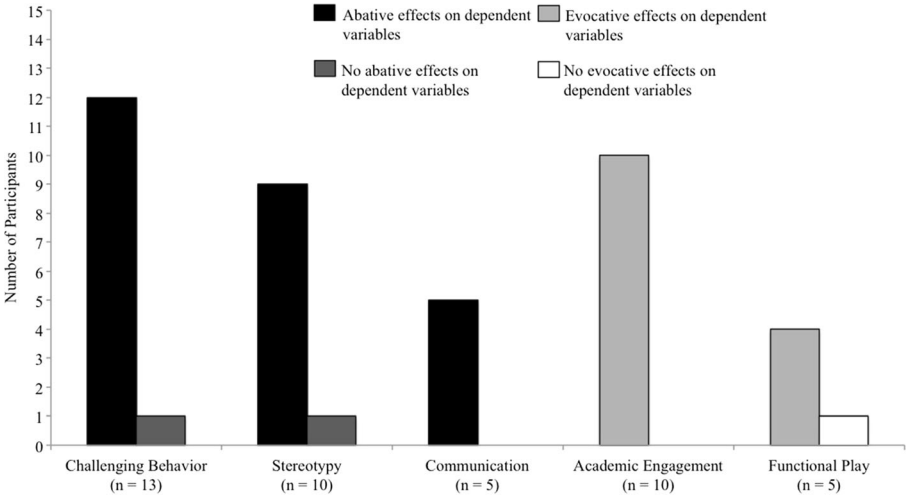

Fig. 1 Summary of dependent variables in the satiation condition across studies

used for comparison purposes to the deprivation condition in which the communication response, manding for tangibles, markedly increased given the EO in effect.

Finally, in 10 % (n = 1) of studies mixed effects were demonstrated in one of the four participants in the satiation condition, wherein no abative effect was noted in challenging behavior and stereotypy and no evocative effect demonstrated in functional play skills. All studies in this review indicated having an effect on dependent variables for at least one participant.

Discussion

This review identified and analyzed 10 studies that evaluated the use of behavioral indicators as a measure of satiation. Abative and evocative effects were found across the vast majority of studies, with only one study having mixed results. This review highlighted the utility of the methodology developed by O'Reilly and colleagues (2009) given the variety of contexts and dependent variables addressed in these research studies.

Prior to the implementation of behavioral indicators of satiation, it appears that many studies were utilizing arbitrarily selected durations of presession stimulus access to alter MOs. The behavioral indicator approach is not only better aligned with the dimensions of applied behavior analysis, but the approach is also effective. The results of this review verify the efficacy of this approach, as an evocative or abative effect was identified in the majority of studies. The results also indicate why this may not be the case for arbitrarily selected durations of stimulus access. The latency to the behavioral indicator varied greatly among participants, with as short a duration as 5 min 40 s and as long as 45 min. This suggests that durations required to alter MOs vary widely among individuals. It is likely that characteristics of the participant and as well as the specific stimulus (e.g., magnitude of preference) affect the duration of

time required to alter MOs. As a result, it is critical to utilize an approach, such as behavioral indicators, that effectively addresses such individual and idiosyncratic influences.

While behavioral indicators of satiation appear to have great utility in systematically altering the influence of MOs, this systematic review has identified some gaps in this literature based that require further investigation. These include (a) the similarities of functions of challenging behavior, (b) lack of consistency in the number of rejection behaviors, and (c) varying effects for behaviors of the same response class.

There were only two functions identified across studies, which included access to tangibles and automatic reinforcement. Of the automatically maintained stereotypic behavior evaluated in the included studies, all involved motor stereotypy with an object, such as repetitive spinning or lining up of toys (e.g., Lang et al. 2010; Rispoli et al. 2014). Therefore, the behavioral indicator of satiation involved the rejection of a tangible item. In one study a participant engaged in vocal stereotypy, but presession access involved the use of matched stimulation in the form of a musical toy, which aligns with the item rejection procedures (Rispoli et al. 2014). In other words, thus far all research involving behavioral indicators of satiation have been limited to behaviors that involve a tangible stimulus.

From the available information it is unclear if the behavioral indicators procedures would be applicable to challenging behavior maintained by attention, escape, or stereotypy that was not related to a particular stimulus (e.g., hand flapping). Logically, the rejection of non-tangible stimuli, such as attention, escape from activities, and covert automatic reinforcement, may be more difficult to operationally define than the rejection of tangible stimuli. For example, it is uncertain how one would reject escape-related behaviors, though there certainly is the potential to manipulate the AO in effect to make escape a less valued reinforcer. Furthermore, there is some evidence to suggest the applicability of behavioral indicators of satiation to other functions, specifically with attention maintained behavior (e.g., Berg et al. 2000).

In addition to participant and function similarity, all studies included in this review described using the behavioral indicators methodology developed by O'Reilly and colleagues (2009). Eight studies used the procedures exactly as described with three item rejection behaviors used. Two studies modified the procedures so that one rejection behavior was displayed before beginning a teaching session. In these two studies, item rejection behavior included a form of elopement, which may have accounted for the use of just one measure of rejection (Lang et al. 2009; Lang et al. 2010). In one of these studies, one participant did not demonstrate decreases in challenging behavior and stereotypy, nor did functional play skills increase following the behavioral indicator of satiation condition (Lang et al. 2010). Using only one measure of item rejection behavior as a behavioral indicator of satiation may not have been a sufficient criterion whereas three item rejection behaviors may have acted as a better measure of an abative effect. However, it is unclear if there may be a connection between the use of one item rejection behavior or the topography of the item rejection behavior and the varied outcomes of this study.

Interestingly, several studies in this review demonstrated that when an AO was in effect for challenging behavior and stereotypy, there was simultaneously an EO for functional behaviors (e.g., communication, academic engagement). It may be the case that challenging behaviors and stereotypy interfere with the display of other, more

appropriate behaviors. For example, some participants already had certain behaviors in their repertoire, such as academic engagement, but were not using these behaviors. The behavioral indicators of satiation procedure may then assist in tapping into existing skills, requiring no or minimal training from practitioners. In other words, having children with ASD engage in functional play is critical in terms of learning and social validity, but often requires extensive intervention. However, it may be that play behaviors are in the repertoire, but are not used when another behavior associated with a stimulus with a higher reinforcing value is present.

Yet from the review it was evident that not just maladaptive behaviors decreased after satiation conditions. In fact, in the studies measuring communication, mands decreased following the behavioral indicators of satiation procedure. It is likely this phenomenon occurred as behaviors associated with the satiated stimulus decreased and behaviors associated with other reinforcers increased. Had other forms of communication, such as conversation skills, which are typically reinforced by attention, been targeted for intervention, results may have been different. Taken together, all of the changes in dependent variables demonstrate the versatility of manipulating MOs both in terms of abative and evocative effects. Specifically, this line of research using behavioral indicators of satiation not only has been shown to reduce behaviors negatively impacting functioning, but also to increase adaptive, on-task behaviors.

Overall, from this review it is evident that the use of behavioral indicators as a measure of satiation is effective as a way of systematically manipulating an AO. However, no study using behavioral indicators of satiation investigated the social validity of the intervention. Therefore, this procedure appears to be effective for practitioner use in applied settings, yet details related to the perceptions of stakeholders, including clinicians, remains unknown.

Limitations of Review

Though efforts were made to minimize limitations associated with this review, there are two drawbacks to be addressed. Only ten studies were identified as meeting the inclusion criteria. Though justified given the relatively recent development of the behavioral indicators of satiation procedure (O'Reilly et al. 2009), limited generalizations can be derived from such a small body of research. Moreover, studies with no effect were not available for review for reasons related to publication, which could have impacted the findings of this review.

Future Research

Future research should replicate the behavioral indicators of satiation methodology (O'Reilly et al. 2009) with older participants, individuals with developmental disabilities other than ASD, across environments, and with caregivers as implementers. Additionally, it should be determined if there are differences in subsequent challenging behavior following presession access conditions with one display of item rejection behavior and three displays of item rejection behavior as behavioral indicators of satiation given clinical significance related to duration of access and opportunities for teaching functional skills.

It should also be considered whether this procedure is useful for challenging behavior maintained by other functions (e.g., attention, escape) as the literature has only addressed tangibly and automatically maintained behaviors. Furthermore, measures of treatment fidelity and social validity should be included in future investigations as this information was strikingly limited in the studies reviewed.

Additionally, more research should further explore why continued access to a stimulus until a specified behavioral indicator of satiation has an abative effect on some behaviors, predominantly challenging behavior, stereotypy, and communication, and evocative effect on others. While some hypotheses were discussed in this paper, future research should continue to pursue an explanation into this phenomenon.

Finally, one study included in this review (Davis et al. 2014) extended the behavioral indicators procedure to include a percentage of access related to mean latency to satiation. Further applications utilizing mean latency to satiation related to presession access periods should be considered.

Conclusion

Studies included in this review of behavioral indicators of satiation suggest that this procedure is effective in clinical practice. Not only does this procedure appear to have the potential to influence abative effects on maladaptive behaviors, but also evocative effects on functional behaviors, which may maximize learning opportunities. Additionally, there is evidence to suggest this procedure generalizes well across environments and response topographies. Overall, the behavioral indicators of satiation procedure appears to be a reliable method of manipulating MO effects.

Compliance with Ethical Standards

Funding This study did not receive funding.

Conflict of Interest The authors declare that they have no conflict of interest.

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The asterisk denotes studies reviewed as part of this research.

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