

## Increasing social time allocation and concomitant effects on mands, item engagement, and rigid or repetitive behavior

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Recent research has developed methods of assessing the function of generic, nonindividualized social interactions. The purpose of this type of assessment is to provide a measure of how an individual may respond to the types of interactions readily available in the natural environment. To date, no research has evaluated how the social time allocation of individuals for whom generic interactions are neutral or aversive could be improved. Moreover, no research has included additional dependent variables that may be functionally related to social time allocation. In the current study, we evaluated the effects of initiating preferred, individualized social interactions on the social time allocation of 3 participants for whom generic interactions functioned as neutral or aversive stimuli. The intervention increased social time allocation for all 3 participants. Next, we evaluated the relation between social time allocation and the occurrence of mands, item engagement, and rigid or repetitive behavior using the intervention data as well as secondary analyses of previously published datasets. The occurrence of mands and rigid or repetitive behaviors changed with improvements in social time allocation and were strongly correlated with social time allocation across participants. Implications for future research on, and the clinical use of, this type of assessment and intervention are discussed.

*Key words:* assessments of sociability, autism spectrum disorder, preference assessment, reinforcer assessment, social interaction

Applied behavior analysis is predicated on individualization and board-certified behavior analysts are ethically obligated to individualize their procedures (Behavior Analyst Certification Board, 2020, Guidelines 2.14). Accordingly, several methods have been developed to identify preferred tangible stimuli that may function as the most efficacious reinforcers for a given individual (e.g., DeLeon & Iwata, 1996; Fisher et al., 1992; see Tullis et al., 2011 for a review). Recently, that same methodology has been extended to the identification of preferred types of social interactions that are likely to

function as reinforcers (e.g., Kelly et al., 2014; Morris & Vollmer, 2019). However, recent research has also developed and evaluated methods of assessing the function of generic, nonindividualized social interactions or social interaction in general (Call et al., 2013; Morris & Vollmer, 2020d, 2021). Such methods, which we will term assessments of sociability, serve a function that is distinct from those that identify preferred, individualized items or interactions.

In the context of behavior analytic services, therapists are often familiar with their clients' preferred items and manding repertoire. As a result, therapists often deliver or offer preferred tangible items or social interactions in the absence of mands by the client (e.g., when implementing differential reinforcement or during play). Alternatively, when the client is required to mand for preferred tangible items

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or social interactions, they often do so with the same therapists who, and in the same setting where, those mands were initially taught. These characteristics of behavior analytic services make the clinical environment somewhat distinct from the natural environment.

Outside of the context of behavior analytic services, individuals in a client's environment may be unfamiliar or inexperienced with the client's preferences and manding repertoire. Due to this lack of familiarity or experience, most individuals in the natural environment may be unlikely to deliver or offer more individualized items or interactions unless they are solicited by the client. Assessments of sociability are designed to emulate these naturalistic conditions. In such assessments (Call et al., 2013; Morris & Vollmer, 2020d, 2021) the experimenter delivers only generic descriptions of the environment (e.g., "It looks like you are having fun with the blocks.") and positive, praise-like statements (e.g., "Wow, that is so cool!"). Experimenters avoid prompting or initiating more specific, individualized types of play or interaction unless the client mands for them. The function of social interaction in general is determined by evaluating how a participant's time allocation changes as the side of the room in which social interactions are available changes within (Morris & Vollmer, 2021) or within and across (Call et al., 2013; Morris & Vollmer, 2020d) sessions. Social interaction is said to be reinforcing for individuals who consistently allocate more time on the side where social interaction is available, neutral for individuals whose time allocation does not systematically vary with changes in the availability of social interaction, and aversive for individuals who consistently allocate more time on the side where no social interactions are delivered.

The results of these assessments can be useful in several ways. First, assessments of sociability can be used diagnostically. If assessments of sociability demonstrate that social interactions

are reinforcing, then they can be utilized as reinforcers therapeutically and programmatically. For example, it could be beneficial to ensure that generic interactions such as praise and conversation are reinforcing before delivering them as consequences for any given client, rather than assuming they are reinforcers and including them for all clients. In contrast, if the assessment indicates social interaction is neutral or aversive for a given individual, then interventions can be implemented to condition social interactions as reinforcers (e.g., Axe & Laprime, 2017; Dozier et al., 2012), facilitate acquisition of fundamental social or play skills (e.g., joint attention, Taylor & Hoch, 2008; mands, Seaver & Bourret, 2020), and reduce or prevent social avoidance and corresponding problems. Moreover, the results of assessments of sociability may provide a more naturalistic, general dependent measure with which to evaluate the effects of these interventions.

Second, it may be useful to conduct assessments of sociability at the onset and intermittently throughout the delivery of behavior analytic services (e.g., every few months). The results could provide a general measure of sociability and how it changes with exposure to adaptive contingencies (e.g., behavior reduction or skill acquisition procedures). Additionally, repeatedly conducting the assessment over time could identify regression in sociability or the emergence of social avoidance and potentially prevent related problems from developing. Assessments of sociability could be incorporated in a way similar to general skills assessments (e.g., VB-MAPP; Sundberg, 2014) or functional analyses of appropriate and problem behavior (e.g., Fahmie et al., 2020).

Third, many behavior analysts provide services to individuals diagnosed with autism spectrum disorder (ASD) which is characterized by a lack of interest in social interactions and corresponding behavioral differences (American Psychiatric Association, 2013). The function of social interaction in general and an individual's

ability to solicit more preferred, individualized interactions are directly related to the diagnostic criteria of ASD. That is, the diagnostic criteria suggest that social interactions may be more likely to function as neutral or aversive stimuli for this population. Moreover, several studies comparing individuals with ASD to peers with no diagnoses (Candini et al., 2017; Gale et al., 2019; Humphrey & Symes, 2011; Ruta et al., 2017) and comparing the relative reinforcer efficacy of preferred social and non-social stimuli (Butler & Graff, 2021; Clay et al., 2018; Leaf et al. 2014) suggest that social stimuli may sometimes be less reinforcing for individuals with ASD. Thus, assessments of sociability may be of utility when providing behavior-analytic services to individuals diagnosed with ASD.

Despite this utility, there are still several unaddressed limitations from the few studies (Call et al., 2013; Morris & Vollmer, 2020d, 2021) evaluating assessments of sociability. Previous research has only recorded social time allocation and similar measures, such as when a participant switches sides in a room. Although social time allocation is the primary dependent variable for determining the function of social interaction, several other behaviors may be functionally related to social time allocation. In assessments of sociability, mands can change the type of interaction available and make social interactions more individualized and more reinforcing. Thus, the occurrence of mands is likely functionally related to social time allocation. Other behavior such as engagement with available items or the occurrence of rigid or repetitive behaviors (RRBs) may also be functionally related to social time allocation. If item engagement and RRB constitute contact with reinforcement contingencies outside of those related to social interaction, then they may decrease the impact of the availability of social interactions or even increase the likelihood of avoiding social interaction if it impedes or degrades the reinforcement obtained from

item engagement or RRB. Including these additional dependent variables is an important next step in improving the utility of assessments of sociability and accounting for variance in social time allocation.

In previous research, assessments of sociability have been described as useful for identifying individuals for whom interventions aimed at improving social time allocation, the function of social interaction, or social and play skills are needed. However, to date, no studies have used assessments of sociability to evaluate the effects of any type of intervention. As a result, it remains unclear whether and how social time allocation could be improved. Evaluating interventions within the context of assessments of sociability is an important next step for demonstrating their utility and applicability. Moreover, interventions that increase social time allocation could have beneficial effects outside of the assessment (e.g., a greater number of learning opportunities, more contact with reinforcement contingencies available in the natural environment).

Outside of the context of assessments of sociability, researchers have evaluated interventions aimed at improving social time allocation and related behaviors. Recently, researchers have evaluated interventions to improve the social behavior of children with ASD within the context of discrete trial training (DTT). For example, researchers have evaluated the effects of rapport-building interventions in which therapists deliver preferred tangible reinforcers and generic social interactions (Shillingsburg et al., 2014; Shillingsburg et al., 2019), the gradual introduction of demands (i.e., demand fading; Cariveau et al., 2020; Shillingsburg et al., 2019), and the differential reinforcement of desired social behaviors (Cariveau et al., 2020). In general, these interventions have been effective in increasing approach to the instructional context (i.e., a table at which a therapist implements DTT), increasing the percentage of time remaining in

the instructional context, and decreasing problem behavior in, or avoidance of, the instructional context.

Researchers have also evaluated interventions to improve the social behavior of children with ASD in the context of play. For example, researchers have prompted participants to engage in preferred leisure activities with adults (Koegel et al., 1987), provided activities that were mutually preferred by participants and their peers (Sivaraman & Fahmie, 2018), and increased how often tangible reinforcers were delivered, social interactions were initiated, and mands were reinforced by implementing behavioral skill training with therapists (Shireman et al., 2016). In general, these interventions have been effective in increasing the percentage of time spent near a social partner, increasing the occurrence of specific social behaviors (e.g., parallel or cooperative play), and decreasing the occurrence of social avoidance.

The interventions described above were successful in increasing the social behavior of children with ASD; however, the availability of social interaction was not systematically manipulated within or across sessions, opportunities to approach and avoid social interaction were not equated, or the availability of social interaction was confounded with other variables (e.g., instructions, preferred tangible items). Although not an issue for the aims of these studies, these characteristics prevented them from isolating social interaction and determining its function. The function of social interaction is important to consider because it elucidates how social interactions affect an individual's behavior and, therefore, is fundamental to assessing and improving any behavior, especially social behaviors. Assessments of sociability (e.g., Morris & Vollmer, 2021) are designed to determine the function of social interaction by allowing for approach and avoidance throughout the assessment, manipulating the availability of social interaction within session, and controlling

the presence of other potentially reinforcing (e.g., leisure activities) or aversive (e.g., demands) stimuli. Therefore, they may be an ideal method with which to evaluate interventions aimed at increasing social time allocation. Additionally, all of the interventions described above involved the identification and use of individualized, preferred edible or leisure items to improve social behaviors in the context of DTT or play. To date, no researchers have evaluated interventions utilizing individualized, preferred social interactions. Highly preferred social interactions can support established responses (Morris & Vollmer, 2020b) and facilitate skill acquisition (Morris & Vollmer, 2020a). Moreover, preferred social interactions may be particularly beneficial when used in interventions for social behavior, because they are more likely to be delivered as consequences for social behavior than edible or leisure items in the natural environment.

In summary, researchers have not included other important dependent variables in assessments of sociability, evaluated interventions aimed at increasing social time allocation within assessments of sociability, or evaluated interventions utilizing preferred, individualized social interactions to increase social time allocation. Thus, the purpose of the current study was three-fold, to evaluate (1) if preferred interactions could be identified for participants with whom social interaction in general was found to function as a neutral or aversive stimulus, (2) if therapists offering preferred interactions would increase social time allocation, and (3) how the occurrence of mands, item engagement, and RRB varied as social time allocation changed from baseline to intervention in the current study. We also included secondary analyses of previously published datasets to evaluate how the occurrence of mands, item engagement, and RRB varied across participants with different levels of social time allocation.

## Method

### Participants and Setting

Three children diagnosed with ASD participated. Felicity was a 5-year-old female who primarily communicated via speech generating device. Felicity displayed a limited repertoire of mands that had only recently been established. In addition to emitting mands via speech generating device, she also emitted some mands as vocal approximations (e.g., “tih” for tickles) and gestures (e.g., hand leading the therapist to clap). Lola was a 3-year-old female who primarily communicated via picture exchange. Lola displayed a limited repertoire of mands that had only recently been established. In addition to emitting mands via picture exchange, she also emitted some mands as gestures (e.g., reaching both hands up to be picked up). Edward was a 7-year-old male who communicated via picture exchange. Edward displayed a limited repertoire of mands. In addition to emitting mands via picture exchange, he also emitted some mands as gestures (e.g., hand leading the therapist to deliver head rubs). All participants also participated in Morris and Vollmer (2021) and their assessment data from that study served as the baseline for the intervention evaluated in the current study. The intervention sessions began within 2 weeks ( $M = 7.67$  days) for all participants, so an updated assessment was not necessary. These three participants were recruited because their assessment results indicated indifference to or avoidance of social interaction. However, their availability and the availability of the therapists who conducted their baseline sessions were also considered. The same therapists conducted baseline and intervention sessions. All therapists were novel to participants prior to the onset of baseline sessions. Sessions were conducted in a 3.1 m by 3.4 m therapy room, which was divided into two halves by a line of tape. Each half of the room contained a small table, two chairs, and identical or nearly identical leisure

items appropriate to participants’ age and functioning level, as described in Morris and Vollmer (2021).

In addition to the participants who received intervention, the current study also included secondary analyses for all participants in Morris and Vollmer (2021). These analyses included some data that were previously published and some data that were previously unpublished. The aim of these analyses was to evaluate how mands, item engagement, and RRB varied across participants who spent different percentages of sessions on the social side. Only the percentage of session on the social side had been reported previously and the response definitions, interobserver agreement, and data are available in Morris and Vollmer (2021). Data on the occurrence of mands, item engagement, and RRB during assessment sessions were previously unpublished and the response definitions, interobserver agreement, and data are presented below.

### General Procedure

#### *Baseline*

Baseline sessions were conducted exactly as described in Morris and Vollmer (2021) and baseline data were reported in that study. For convenience, the main procedural characteristics of the assessment will be reiterated here. At the beginning of each session an individual other than the therapist brought the participant into the room and said, “Go wherever you want.” The therapist began the session on one side of the room and switched sides every 2 min (i.e., on a fixed-time 2-min schedule) and told the participant when they were changing sides (e.g., “I’m going to go play over here”). The therapist delivered social interactions when the participant was on the same side of the room as they were, so the side that the therapist was on was deemed the social side. The therapist did not deliver or attempt to initiate social interactions when the participant

was on the opposite side of the room from them, so the side that the therapist was not on was deemed the alone side. Thus, after entering the session room, the participant could avoid social interaction by staying on the opposite side of the room from the therapist (i.e., alone side) or could maintain access to social interaction by staying on the same side of the room as the therapist (i.e., social side). However, in order to consistently maintain access to, or avoid, social interaction participants had to change their behavior contingent on therapist movement.

When the participant was on the alone side, the therapist maintained a neutral gaze and body orientation (i.e., neither toward or away from the participant) and did not deliver social interaction. Contingent on the participant meeting criteria for being on the social side, the therapist delivered generic social interactions about every 10 s (i.e., similar to a variable interval 10-s schedule). These social interactions included descriptions of the environment or the participant's behavior (e.g., "You're reading [insert name of book]"), praise (e.g., "You're the coolest!"), and participant-directed play (e.g., interacting with toys that the participant showed interest in or interacted with). The therapist reinforced all mands for social interaction or specific types of play. Only mands that clearly specified a consequence and would occasion a change in the behavior of a novel listener were reinforced (e.g., taking the therapist's hand and leading them to roll a car or saying, "tickles"). Therapists would have also reinforced mands for the therapist to change sides (e.g., social switch, "Play with me"; avoidant switch, handing a card or pressing a button that said "break, please"), but such mands did not occur during baseline or intervention for Felicity, Lola, or Edward. The therapist responded to unclear mands (e.g., unintelligible vocal behavior or imprecise gestures) by saying something like, "I'm not sure what you want." Additionally, therapists

never prompted specific types of play or interaction and never delivered instructions or asked questions unless they were related to a conversation initiated by the participant. Thus, all therapist-initiated interactions were generic, whereas any specific, individualized interactions only occurred following mands by the participant.

All sessions were 10 min in duration. However, data from only the first 8 min of each session were analyzed and displayed in the figures. Data from 10- and 8-min sessions have been shown to allow for similar conclusions about the function of social interaction (see supplemental material for Morris & Vollmer, 2021). Moreover, data from the first 8 min of each session were easier to interpret because the amount of time the therapist spent on the left and right sides of the room were equal (e.g., switching every 2 min allowed for a total of 4 min on the left and 4 min on the right). For these reasons, we analyzed and displayed the data as 8-min sessions. Following baseline, a graphic-interchange-format-based (GIF-based) paired-stimulus preference assessment (PSPA) was conducted.

### ***GIF-based PSPA***

A GIF-based PSPA was conducted as described in Morris and Vollmer (2020c). Potentially reinforcing social interactions were identified via caregiver and clinician report. GIF-based PSPAs were conducted by a familiar adult instead of the therapist who conducted baseline, exposure, and interventions sessions. A total of five forms of social interaction as well as a control option with no programmed consequences were evaluated for each participant. Each GIF-based PSPA consisted of 15 trials. Participants were exposed to the contingencies of selecting each GIF prior to the assessment. During exposure trials, the experimenter prompted the participant, using a combined vocal and gestural prompt, to select an image and the consequence depicted by the GIF

selected was delivered. Each type of social interaction was delivered for approximately 5-10 s. The order in which each consequence was sampled was determined randomly by the computer program.

At the beginning of each trial, the computer was presented to the participants, the computer displayed each of the GIFs, and then they were instructed to "Pick one." Selection of either GIF resulted in the delivery of the social interaction that it depicted. If the participant made no selection, the experimenter waited for 5 s and then represented the array and instruction. If no selection was made within 5 s of re-presentation, then the computer would have been removed and the 5-s intertrial interval would have begun. However, all participants selected a GIF on the first presentation of every trial. The computer program presented a GIF of each social interaction with a GIF of each other social interaction in a pairwise manner. The percentage of trials in which each social interaction was selected generated a hierarchy of preference. All participants made a selection on each trial and a differentiated hierarchy of preference was obtained. The three most highly preferred stimuli were used in subsequent phases of the study. Felicity's most preferred interactions were tickles, bouncing on an adult's lap, and head rubs. Lola's most preferred interactions were being picked up, tickles, and spins. Edward's most preferred interactions were being picked up, dip (i.e., sitting on lap and leaning back and forth), and zoom (i.e., fast, repetitive head and back rubs while saying "zoom").

### ***Exposure Session***

Prior to the onset of the intervention, an exposure session was conducted to ensure that the participants contacted the change in contingencies during the intervention. The arrangement and procedures for this session were the same as baseline, with three exceptions. First, the sessions only lasted 5 min and the therapist

switched sides about every minute. Second, the participant was prompted to go to the social side of the room and to follow the therapist if they did not do so within 30 s of the therapist switching. Third, the therapist initiated or offered one of the participants three highly preferred social interactions (according to the preference assessment) about once every 10 s (i.e., similar to a VI 10 s schedule) contingent on the participant being on the social side.

### ***Intervention***

The intervention began following the exposure sessions. The arrangement and procedure during the intervention were the same as baseline, with the exception that preferred interaction was initiated or offered by the therapist in addition to generic interactions. Specifically, contingent on a social switch and the participant remaining on the social side for 3 consecutive seconds, one of the participant's three most highly preferred interactions was initiated or offered by the therapist. Subsequently, if the participant remained on the social side, the therapist initiated preferred interactions about once every 30 s (i.e., similar to a VI 30-s schedule). Additional preferred interactions were delivered if participants mandated for them in any way (e.g., vocally, by hand-leading). All preferred, individualized social interactions were delivered for 5-10 s. The therapist initiated preferred interactions by putting their hands out to the participant and saying things like, "Do you want (insert label for interaction)?" If the participant displayed approach behaviors (e.g., positive affect, moving or reaching toward the therapist) or did not change their behavior in response to the initiation, then the social interaction was delivered. If the participant displayed avoidance behavior (e.g., negative affect, moving or pushing away from the therapist) then the social interaction was not delivered. Avoidance responses were observed contingent on the therapist offering the social interaction in one session with Lola and two sessions with

Edward. If avoidance responses occurred while the social interaction was already being delivered, then the social interaction would have been terminated, but this never occurred.

### Response Measurement and Interobserver Agreement

As in Morris and Vollmer (2021), the primary dependent variable was the percentage of session time spent on the social side. The frequency of social switches, the frequency of avoidant switches, and the frequency of therapist movement were also recorded. Data were collected using a mobile data collection application, Countee<sup>®</sup>, that produced a data stream of the occurrence of each of the dependent variables across time. Percentage of session time on the social side was calculated by dividing the duration the participant was on the social side by the total session duration. Participants were recorded as being on the social side when both of their feet were on the same side of the room as the therapist. Participants were recorded as being on one side of the room until they met criteria for being on the other side. Thus, if the participant had one foot on both sides of the line, or both feet on top of the line, then they were recorded as being on the side they were on previously until they met criteria for being on the other side (i.e., both feet on that side of the line). Thus, participants were always on either the social or alone side, so the percentage of session on the alone side was calculated by subtracting the percentage of session on the social side from 100.

*Social switches* were defined as moving from the alone side of the room to the social side of the room or manding (e.g., selecting the button that said, “play with me” on their speech generating device) for the therapist to come to the same side as the participant. Mands for social switches did not occur during the baseline or intervention sessions for the participants in the current study. *Avoidant switches* were defined as

moving from the social side of the room to the alone side of the room or manding (e.g., pushing the therapist to the other side of the room) for the therapist to go to the opposite side of the participant. Mands for avoidant switches did not occur during the baseline or intervention sessions for the participants in the current study. *Therapist movement* was defined as the therapist moving across the line that divided the room, using the same criteria that were used for participant movement.

A second, independent observer collected data for an average of 35% of sessions with each participant. Interobserver agreement (IOA) was calculated using the proportional method, by dividing the session into 10-s intervals and comparing each observer’s data interval-by-interval. The smaller number of seconds on the social side was divided by the larger number of seconds on the social side, and the smaller frequency of social or avoidant switches was divided by the larger frequency. The quotients were summed, divided by the total number of intervals, and multiplied by 100 to yield a percentage. For all participants, IOA scores averaged 97% (range, 95%-99%) for duration on the social side, 95.3% (range, 93%-97%) for social switches, and 96.3% (range, 94%-98%) for alone switches.

Mands, item engagement, and RRB were all recorded using partial-interval recording with 10-s intervals. These behaviors were recorded for baseline and intervention phases for the three participants in the current study as well as the 18 previously published datasets included in Morris and Vollmer (2021). *Mands* were defined as any instance of verbal behavior that specified a particular type of play or social interaction. Only mands that would effectively produce the corresponding change in behavior for a listener who was unfamiliar with the participant were recorded. Mands emitted vocally, via picture exchange, via speech generating device, and gesturally (e.g., hand leading the therapist to color with crayons) were observed.



For participants who communicated via picture exchange or speech generating device, no changes were made to their available response options. Thus, participants could only engage in mands for which they had a corresponding picture or button. In some cases, participants supplemented mands made via picture exchange or speech generating device with gestural or partial vocal mands (e.g., handing a card that read, “play with me” and saying, “spih, spih” would result in the therapist spinning in circles with the child). *Item engagement* was defined as the participant manipulating an item with their hands for at least three consecutive seconds. *RRB* was defined as the participant engaging in repetitive and invariant movements of one or more body parts that seemed to have no socially mediated function. More specifically, RRB was defined as the same response occurring at least three times within the same interval. RRB could be vocal (e.g., saying “ah ah ah”) or nonvocal (e.g., body rocking or spinning) and could include or occur during item engagement. This general definition of RRB was used instead of more individualized definitions to facilitate comparison across participants. A second trained independent observer collected data for an average of 29.7% sessions (range, 26.67% to 37.5%) across participants, including previously published datasets included in Morris and Vollmer (2021) as well as the baseline and intervention sessions in the current study. IOA was calculated using the interval agreement method, by comparing each observer’s data interval-by-interval and scoring any interval in which both observers recorded the presence or absence of the response as an agreement. The percentage of intervals with agreement was calculated by dividing the number of intervals for which there was agreement by the total number of intervals and multiplying the quotient by 100 to yield the IOA score. Mean agreement was 95.6% (range, 91.7% to 100%) for mands, was 97.6% (range, 87.1% to 100%) for item engagement, was 94.5% (range, 83.33% to 100%) for RRB.

### Experimental Design and Data Analysis

The effect of the intervention on sociability was evaluated in a multiple-baseline design across participants. One to three sessions were conducted per day across baseline and intervention phases. Thus, the intervention was conducted and evaluated across multiple days for all participants. For each dataset we evaluated the percentage of session on the social side and calculated the risk ratios for social and avoidant switches (as described by Morris & Vollmer, 2020d). Risk ratios were included to quantify the degree to which therapist movement made social or avoidant switches more or less likely to occur relative to how likely they were in general (i.e., regardless of therapist movement) and to evaluate whether the effect of therapist movement changed during the intervention. Risk ratios were calculated by dividing the probability of social or avoidant switches within 10 s of therapist movement (i.e., conditional probability) by the probability of social or avoidant switches during any 10 s interval, regardless of therapist movement (i.e., unconditional probability). Risk ratios of greater than 1.0 indicate that switching was more likely given a therapist switch than it was in general, regardless of a therapist switch. Risk ratios equal to 1.0 indicate that switching was not any more likely given a therapist switch than it was in general. Risk ratios less than 1.0 indicate that switching was less likely given a therapist switch than it was in general. These calculations were identical for baseline and intervention sessions and not adjusted to attempt to account for the delivery of interactions that may have inhibited movement. Such adjustments were not necessary because preferred, individualized reinforcers were initiated or offered (i.e., not delivered/forced). Thus, the intervention in no way prevented participants from avoiding the therapist because the social interactions were only delivered in the absence of avoidance responses or negative affect.

We also calculated a nonparametric measure of effect size, nonoverlap of all pairs (NAP; Parker & Vannest, 2009) by comparing the duration on the social side during each baseline session to the duration on the social side during each intervention session. Each comparison was evaluated in terms of whether the intervention constituted a decrease, no change, or an increase in duration on the social side relative to baseline and calculating the proportion of comparisons that constituted an increase. Finally, in our secondary analyses of mands, item engagement, and RRB we calculated Pearson correlation coefficients to quantify the relation between the average percentage of intervals with mands, item engagement, or RRB and the average percentage of session on the social side across all participants in Morris and Vollmer (2021).

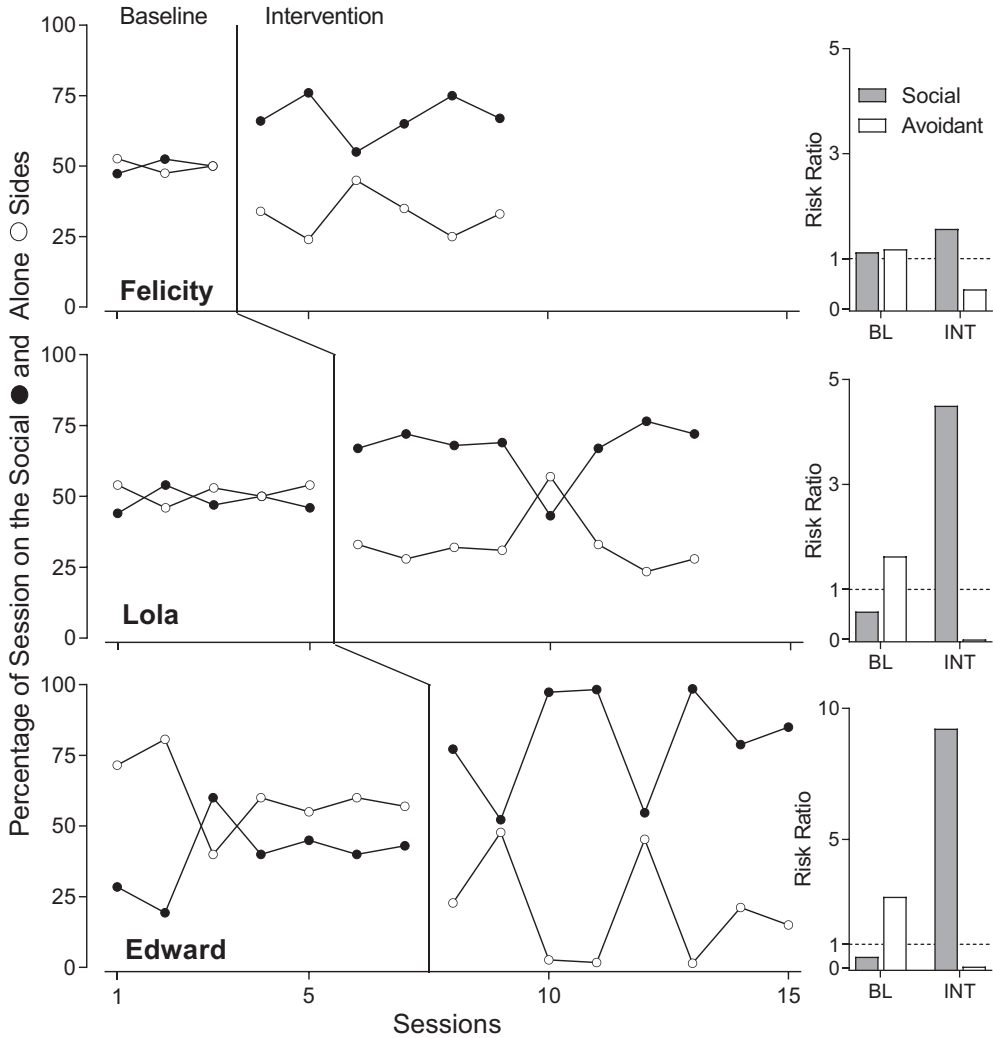
## Results

Figure 1 depicts the baseline and intervention data for Felicity, Lola, and Edward in the top, middle, and bottom panels, respectively. In each panel the left graph displays the percentage of session on the social side, whereas the right graph displays risk ratios for social and avoidant switches. The top panel of Figure 1 depicts Felicity's results. The therapist's initiation of preferred interactions resulted in a moderate, but consistent, increase in the duration on the social side (NAP: 1.0). Additionally, the initiation of preferred interaction resulted in an increase in the risk ratio for social switches and a decrease in the risk ratio for avoidant switches. The probability of social and avoidant switches was essentially unaffected by the therapist movement in baseline (i.e., risk ratios close to 1), whereas during the intervention Felicity was about 1.5 times more likely to follow the therapist than she was to switch sides in general and less likely to avoid the therapist than she was to switch sides in general. For baseline sessions, Felicity averaged 1.3 social switches within 10 s of therapist movement

and 17.7 other (i.e., greater than 10 s following therapist movement) social switches. She averaged 1.7 avoidant switches within 10 s of therapist movement and 21.3 other avoidant switches. For intervention sessions, Felicity averaged 1.7 social switches within 10 s of therapist movement and 16 other social switches. She averaged 0.3 avoidant switches within 10 s of therapist movement and 11.8 other avoidant switches.

The center panel of Figure 1 depicts Lola's results. For Lola, the therapist's initiation of preferred interactions also resulted in a moderate, but consistent, increase in the duration on the social side (NAP: .88). Additionally, the initiation of preferred interaction resulted in an increase in the risk ratio for social switches and a decrease in the risk ratio for avoidant switches. In baseline, Lola was more likely to avoid the therapist than she was to switch sides in general and less likely to follow the therapist than she was to switch sides in general. In contrast, during the intervention Lola was about 4.5 times more likely to follow the therapist when they moved than she was to switch in general and less likely to avoid the therapist than she was to switch in general. For baseline sessions, Lola averaged 0.2 social switches within 10 s of therapist movement and 5.2 other (i.e., greater than 10 s following therapist movement) social switches. She averaged 0.8 avoidant switches within 10 s of therapist movement and 7.4 other avoidant switches. For intervention sessions, Lola averaged 2.3 social switches within 10 s of therapist movement and 7.4 other social switches. She averaged 0 avoidant switches within 10 s of therapist movement and 9.25 other avoidant switches.

The bottom panel of Figure 1 depicts Edward's results. For Edward, the therapist's initiation of preferred interactions resulted in a larger (e.g., sometimes nearly 100% of the session was spent on the social side) and more variable increase in the duration on the social side

**Figure 1***Percentage of Session on Social Side and Risk Ratios for Baseline and Intervention*

(NAP: .96). Additionally, the initiation of preferred interaction resulted in an increase in the risk ratio for social switches and a decrease in the risk ratio for avoidant switches. In baseline, Edward was more likely to avoid the therapist than he was to switch in general and less likely to follow the therapist than he was to switch in general. In contrast, during the intervention Edward was about nine times more likely to follow the therapist than he was to switch in general and less likely to avoid the therapist

than he was to switch in general. For baseline sessions, Edward averaged 0.29 social switches within 10 s of therapist movement and 8.3 other (i.e., greater than 10 s following therapist movement) social switches. He averaged 1.9 avoidant switches within 10 s of therapist movement and 9.86 other avoidant switches. For intervention sessions, Edward averaged 2.7 social switches within 10 s of therapist movement and 4.3 other social switches. He averaged 0.1 avoidant switches within 10 s of

therapist movement and 9.5 other avoidant switches.

The left panels of Figure 2 display the data for mands (top panel), item engagement (middle panel), and RRB (bottom panel) relative to the percentage of session on the social side during baseline and intervention phases (grey and white data points, respectively). Note that, for clarity, the range of the x and y-axes are sized to the range of the data instead of from 0 to 100. The top-left panel shows the average duration on the social side and average percentage of intervals with mands for Felicity (squares), Lola (triangles), and Edward (diamonds) during baseline and intervention. As the percentage of session on the social side increased for all participants during the intervention, the percentage of intervals with mands also increased. These data suggest that the percentage of session on the social side and percentage of intervals with mands may be functionally related.

The middle-left panel shows the average duration on the social side and average percentage of intervals with item engagement for Felicity, Lola, and Edward during baseline and intervention. As the percentage of session on the social side increased for all participants during the intervention, the percentage of intervals with item engagement decreased for Lola and Edward but increased for Felicity. Given the inconsistency in the direction of change, these data suggest that the percentage of session on the social side and percentage of intervals with item engagement may not be functionally related.

The bottom-left panel shows the average percentage of session on the social side and average percentage of intervals with RRB for Felicity, Lola, and Edward during baseline and intervention. As the percentage of session on the social side increased for all participants during the intervention, the percentage of intervals with RRB decreased for all participants. These data suggest that the percentage of session on the social side and the percentage of intervals with mands may be functionally related.

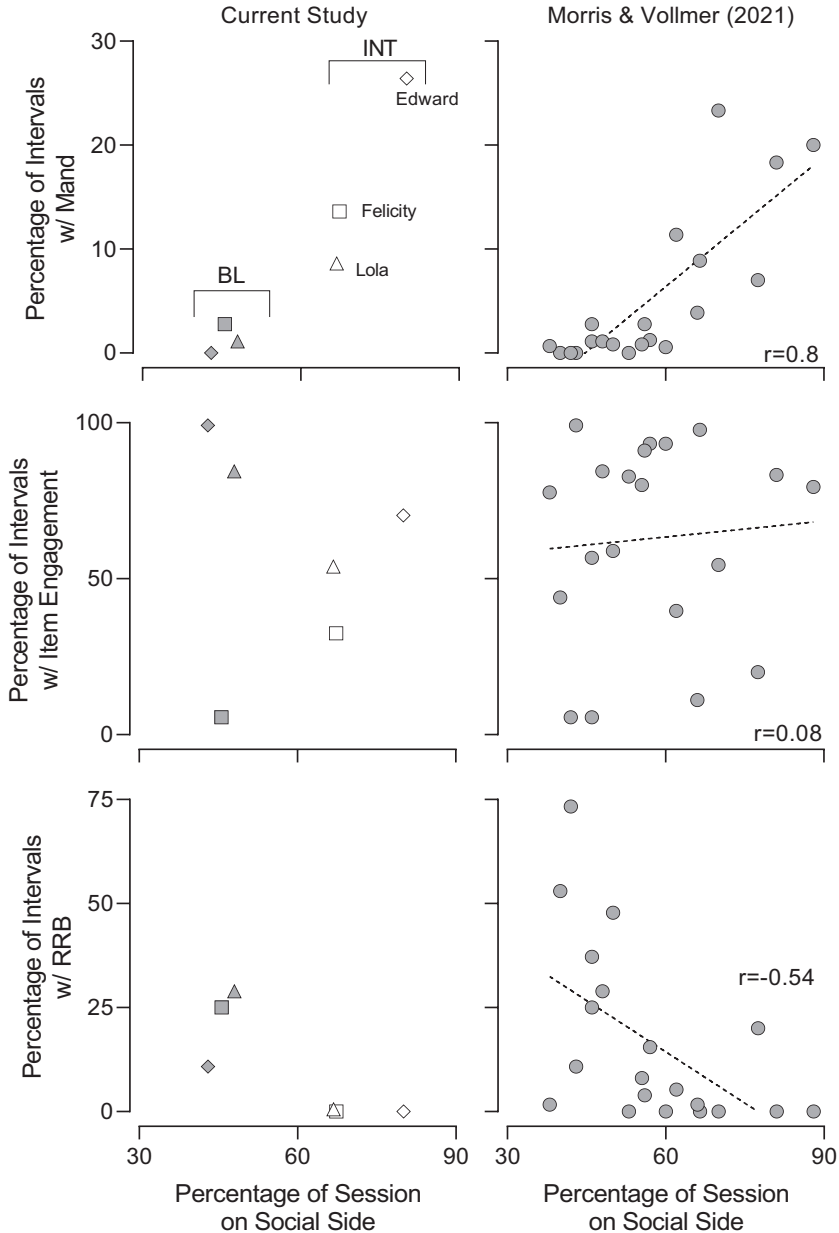
The right panels of Figure 2 display the results of the secondary analyses: the percentage of intervals with mands (top panel), item engagement (middle panel), and RRB (right panel) and the percentage of session on the social side for all participants in Morris and Vollmer (2021). Note that, for clarity, the range of the x and y-axes are sized to the range of the data instead of from 0 to 100. Additionally, for each panel, a line of best fit (i.e., the equation that minimized the sum of squared residuals) was included to facilitate visual analysis. The top-right panel shows the average percentage of sessions on the social side and average percentage of intervals with mands for each participant in Morris and Vollmer (2021). Those participants who allocated the majority of their time to the social side manded in a greater percentage of intervals than those who allocated the majority of their time to the alone side. A Pearson correlation coefficient of 0.8 (95% confidence interval [CI]: 0.56 to 0.92) was obtained for these data.

The middle-right panel shows the average percentage of session on the social side and average percentage of intervals with item engagement for each participant in Morris and Vollmer (2021). No clear relationship was observed between the percentage of session on social side and percentage of intervals with item engagement. A correlation coefficient of 0.08 (95% CI: -0.38 to 0.5) was obtained for these data.

The bottom-right panel shows the average percentage of session on the social side and average percentage of intervals with RRB for each participant in Morris and Vollmer (2021). Those participants who allocated less than or equal to 50% of session to the social side often engaged in RRB for a greater percentage of intervals than those who allocated more time to the social side. A correlation coefficient of -0.54 (95% CI: -0.8 to -0.13) was obtained for these data.

**Figure 2**

*Percentage of Intervals with Mands, Item Engagement, or RRB Relative to the Percentage of Session on the Social Side*



### Discussion

The current study demonstrates that individualized, preferred interactions can be identified for individuals who are indifferent to or avoidant of social interaction in general and

that preference assessments such as the one described by Morris and Vollmer (2020c) may be useful with this population. The potential utility of these individualized, preferred social interactions and their efficacy as reinforcers was

demonstrated during the intervention. When the therapist offered more preferred, individualized social interactions, a consistent increase in social time allocation was observed for all participants. The intervention also resulted in noticeable changes in participants' patterns of switching and response to a therapist's movement. For all participants, the risk ratio for social switches increased during the intervention, whereas the risk ratio for avoidant switches decreased. One possible explanation for the changes in the risk ratio data is that the therapists' initiation of preferred interactions was sufficient to establish the therapist or their location as a discriminative stimulus. That is, being near the therapist became strongly correlated with the availability of reinforcing social interactions and the participants began to change their behavior contingent on therapist's movement. These data suggest that risk ratios provide data that are functionally related to, but distinct from, percentage of session on the social side and would be useful to include in future research on assessments of sociability.

The intervention also affected other behaviors such as mands and RRB. During baseline, all participants in the current study infrequently emitted mands and sometimes displayed RRB. However, during the intervention all participants became more likely to mand and less likely to display RRB. These data demonstrated that mands may be functionally related to social time allocation. This is not surprising, given that mands are the only way more individualized, preferred interactions may be obtained during the assessment. Therapists offering more preferred interactions may have occasioned mands that would not have been emitted otherwise. When the newly occasioned mands contacted reinforcement and became more likely to occur, they may have increased the overall reinforcing efficacy of interactions being delivered and thus increased social time allocation. These data also demonstrated that RRB may be functionally related to social time

allocation. RRB may constitute an alternative source of relatively high magnitude reinforcement that decreased participants' sensitivity to the availability of other sources of reinforcement like social interaction. However, as the reinforcer efficacy or magnitude of social interactions increases, participants may become more sensitive to the contingencies for social time allocation and allocate less time to alternative sources of reinforcement like RRB. This type of relation would be consistent with quantitative models of behavior in single-alternative arrangements (Herrnstein, 1970; McDowell & Klapes, 2020). The relations between mands, RRB, and percentage of session on the social side were also supported by the secondary analyses for data published by Morris and Vollmer (2021). These analyses demonstrated that, across a larger number of participants, mands were positively correlated with social time allocation and RRB was negatively correlated with social time allocation. The occurrence of behaviors such as mands, item engagement, and RRB are critical to providing a more complete explanation of an individual's social time allocation. Thus, these additional measures will be important to include in clinical practice and future research incorporating assessments of sociability.

The diagnostic criteria of ASD (American Psychiatric Association, 2013) suggest that social interactions may be unlikely to function as reinforcers for individuals with ASD. Moreover, an ASD diagnosis may be misunderstood as describing immutable characteristics of the individual or limits to their ability or potential. Recent research (Call et al., 2013; Morris & Vollmer 2020d, 2021) conducting assessments of sociability with children with ASD have demonstrated social interactions to function as reinforcing stimuli for 15 out of 34 datasets (44%), neutral stimuli for 12 out of 34 datasets (35%), and aversive stimuli for 7 out of 34 datasets (21%). Although more research is needed, the available data demonstrate that it is

unreasonable to assume social interaction in general is unlikely to function as a reinforcer for individuals with ASD. Rather, the function of social interaction should be evaluated on an individual-by-individual basis. Most importantly, an ASD diagnosis, or assessment results indicating an individual is indifferent to, or avoidant of, social interaction, does not indicate that the individual cannot or will not display more social behaviors. The current study demonstrates that more individualized, preferred interactions can be identified, and simply making these interactions available to the child can greatly increase their amount of social time allocation, change how they respond to therapist behavior, increase mands, and decrease RRB.

There are several limitations and corresponding future directions for the current study. Perhaps the most significant limitation is that we did not include a reversal of the contingencies in which the therapist stopped initiating individualized, preferred interactions. The intervention stopped after demonstrating that preferred interactions can be used to increase social time allocation. The intervention in the current study was only intended to be a preliminary demonstration of how social time allocation may be increased. However, a more complete intervention would need to evaluate whether improvements in social behaviors would have maintained after the intervention and included methods of facilitating maintenance and generalization to different therapists and more naturalistic settings. A relatively straightforward, important next step would be to evaluate, following an intervention like the one in the current study, if improvements in social time allocation and manding would maintain if the therapist stopped initiating preferred interactions. If improvements maintained in baseline conditions, then variables related to generalization could be evaluated next (e.g., different therapists, more naturalistic environment). If improvements did not maintain, then a more intensive intervention consisting of mand training for preferred

types of play and social interaction could be evaluated. Future research should ensure that interventions improve participants' ability to induce the therapist to interact in more reinforcing ways and evaluate maintenance in baseline conditions (i.e., only generic interactions) and generalization to more naturalistic settings with different therapists. Finally, the inclusion of other dependent measures such as mands, item engagement, and RRB may aid in explaining intervention outcomes and predicting which types of interventions are likely to be effective.

Another limitation of the current study is that we did not include assessments to characterize important aspects of participants' repertoires. It would have been useful to conduct general skills assessments (e.g., VB-MAPP; Sundberg, 2014) with the aim of precisely describing each participant's communication repertoire, leisure and play skills, and early learning or pre-academic skills (e.g., imitation, instruction following). Relatedly, it may have been useful to include observation (e.g., Autism Diagnostic Observation Schedule; Lord et al., 2000) and survey-based (e.g., Social Responsiveness Scale; Constantino & Gruber, 2012) measures related to sociability and the severity of ASD symptomology. Such assessments could serve to further characterize participants and should be included in future research. The results of these assessments may aid in accounting for variance in responding across participants, inform more comprehensive interventions, and increase the generality and replicability of results.

Another limitation of the current study is that general, nonindividualized definitions for mands, item engagement, and RRB were utilized to allow for comparison across participants. These definitions were necessary for a fair comparison across individuals and within individuals across time, but also may obscured some characteristics of these behaviors that may be of interest and important to consider. Any behavior that clearly specified a reinforcer and would have effectively changed the behavior of

a novel listener was recorded as a mand, but characteristics such as clarity, complexity, and modality (e.g., vocal or gestural) may all impact how effective a mand is at changing the behavior of a listener. Similarly, any contact with an item for at least 3 s was recorded as item engagement, but it may also be useful to differentiate between appropriate and inappropriate item engagement and solitary, parallel, or cooperative play. The differences in these characteristics of item engagement may influence whether or not and how adults or peers attempt to interact with an individual. Finally, our definition of RRB only captured behaviors that occurred repeatedly within a given 10-s interval and did not capture rigid and repetitive behaviors that occurred in more extended chains or occurred with too large an interresponse time to occur three times within 10 s. More individualized definitions of RRB or a general definition with a larger window of occurrence may have produced different results and captured some RRB that was missed in our analyses. These response characteristics and variations in response definition would be useful to consider in future research on, or clinical use of, assessments of sociability.

Time allocation near or away from an adult was measured in the current study. It is possible that assessing time allocation near or away from peers may yield different conclusions that could be useful, given that peers may account for a large portion of the contingencies of reinforcement placed on children's behavior. However, for children enrolled in preschool, elementary school, or early intensive behavior intervention programs, time allocation relative to adults is also of importance. Avoidance of an adult could limit a child's number of learning opportunities and access to reinforcers that they cannot produce or obtain themselves. It will be important for future research to adapt the procedures of the current study to be conducted with peers and to evaluate correspondence between assessments with adults and peers.

Although many researchers have evaluated more complex social or play behavior and shown methods of improving them (e.g., Sivaraman & Fahmie, 2018), the evaluation of time allocation may be especially useful with individuals who lack those more complex social skills and could also allow for distinct conclusions.

In summary, the current study demonstrates that social time allocation can be improved using preferred, individualized interactions and that several additional dependent measures such as risk ratios for social and avoidant switches, mands, and RRB are functionally related to social time allocation and important to include in assessments of sociability. Assessing and improving social time allocation is critical to ensuring that individuals can contact many of the reinforcers and learning opportunities that are available in the natural environment. Future research should continue to improve the efficiency and feasibility of assessments of sociability, evaluate more comprehensive interventions including measures of generalization and maintenance, and continue to improve the accuracy and precision of assessments of sociability.

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