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An evaluation of strengthening precursors to increase compliance with instructions

Jacqueline P. Rogalski
Western New England University

AN EVALUATION OF STRENGTHENING PRECURSORS TO INCREASE COMPLIANCE WITH INSTRUCTIONS

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Jacqueline P. Rogalski
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Eileen Roscoe Digitally signed by Eileen Roscoe Date: 2023.04.04 14:04:01 -04'00'

Dr. Eileen M. Roscoe, Committee Chair

Rachel Thompson Digitally signed by Rachel Thompson DN: cn=Rachel Thompson, o=Western New England University, ou=Department of Psychology, email=rthompson@wne.edu, c=US Date: 2023.04.03 09:33:29 -04'00'

Dr. Rachel H. Thompson, Committee Member

Jason Bourret Digitally signed by Jason Bourret Date: 2023.04.04 14:07:43 -04'00'

Dr. Jason C. Bourret, Committee Member

William H. Ahearn, Ph.D., BCBA-D, LABA Digitally signed by William H. Ahearn, Ph.D., BCBA-D, LABA Date: 2023.04.01 15:41:14 -04'00'

Dr. William H. Ahearn, Committee Member

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Abstract

Low compliance is a common childhood problem and has been shown to be correlated with poor social and behavioral outcomes later in life. One empirically validated method for increasing compliance involves teaching individuals to emit precursors to compliance (e.g., making eye contact). Although this method has been found sufficient for increasing compliance in typically developing individuals, the generality of this approach to individuals with intellectual disabilities remains unclear. The purpose of this study was to assess the generality of this approach by using prompting and reinforcement to teach individuals with intellectual disabilities to emit precursors (sitting, orienting, eye contact, observing response) to compliance. Two tasks were trained in a discrete-trial format for all participants, and instructions were presented remotely via telehealth for two of the four participants. Training precursors was sufficient to increase compliance for two participants, whereas direct teaching of compliance was necessary for the other two participants.

An Evaluation of Strengthening Precursors to Increase Compliance with Instructions

Compliance is defined as completing an instruction within a designated latency, often between 6 and 10 s (see Stephenson & Hanley, 2010 and Lipschultz & Wilder, 2017 for a discussion of the empirical derivation of this timeframe). Noncompliance is the inverse of compliance and can be defined as engaging in any behavior other than completing a known instruction within the designated timeframe (Kalb & Loeber, 2003; Lipschultz & Wilder, 2017). In a recent review, Lipschultz and Wilder (2017) suggest that noncompliance occurs in anywhere between 25% to 85% of children and adolescents. Noncompliance is associated with a variety of psychiatric diagnoses later in life and may have a detrimental effect on social and behavioral development (Kalb & Loeber, 2003). Additionally, caregivers and practitioners report noncompliance as highly problematic (Kalb & Loeber, 2003) and teachers nominate its inverse, compliance, as one of the most essential skills for school readiness (Lin et al., 2003). Given the reported importance of compliance, as well as the reported prevalence of and problems associated with noncompliance, it is valuable for researchers to develop strategies to increase compliance.

One method to increase compliance in typically developing populations is to prompt and reinforce precursors to compliance. Kraus et al. (2012) compared two preschoolers' compliance with typical preschool classroom instructions (e.g., "give me _____," "what color is this?") before and after an intervention to increase four identified precursors to compliance: stopping competing behavior (e.g., no longer engaging with a leisure activity), orienting toward the speaker, making eye contact, and saying "yes." The researchers conducted three conditions: pre-training baseline, training precursors, and post-training. During the pre-training baseline, the researchers called the participants' name during child-led structured play activities (e.g., art,

block building), paused for 2 s to allow for precursors to occur, and issued an instruction. No programmed consequences were delivered for precursors. If the participants complied within 3 s of the instruction, the researchers delivered praise and initiated the next trial within 2 min. If compliance did not occur within 3 s of the instruction, then praise was not delivered, and the researchers initiated the next trial within 2 min. During the training precursors condition, the researchers used behavior skills training (BST) to teach participants to emit the four precursors in response to their name call. BST included instructions (i.e., describing what each of the four precursors entailed), modeling the precursors, role playing, and feedback. The feedback component included the delivery of tokens, exchangeable for 1-min of free play, contingent on the occurrence of all four precursors; if the participants did not emit any of the precursors, the researchers described and modeled the desired behavior and then initiated the next trial. During the subsequent post-training condition, instructions were reintroduced to evaluate participants' compliance during the child-led structured play context. This condition included the same antecedent variables as the pre-training baseline (i.e., calling the participant's name, pausing for 2 s for precursors to occur, and then presenting an instruction). However, unlike the pre-training condition, there were programmed consequences in effect for precursors during the post-training condition. Specifically, tokens were delivered contingent on the occurrence of all four precursors. If one or more precursors did not occur, then the experimenter delivered corrective feedback (i.e., presented instructions and modeling for missing precursors, and delivered the token contingent on the occurrence of the modeled precursor). As in the pre-training condition, compliance resulted in praise. Precursors increased during post-training for both participants. Although intervention components were not in effect for compliance, this behavior also increased for both participants. These data suggest that increasing precursors can increase

compliance without direct intervention. However, because programmed consequences for precursors were in effect during the post-training condition, it remains unclear whether compliance would have occurred at similarly high levels when the intervention for precursors was removed.

To further clarify the effects of improving precursors on compliance, Beaulieu et al. (2012) conducted a similar study but arranged consistent consequences across the pre-training and post-training conditions for 12 typically developing preschoolers during child-led structured play activities. As in the Kraus et al. study, there were no programmed consequences in effect for precursors and compliance resulted in praise during the pre-training baseline condition. During the training precursors condition, the experimenters used BST to teach participants to emit four precursors in response to an individual name call (e.g., “Johnny!”) and a group call (e.g., “everyone!”). During post-training, Beaulieu et al. (2012) extended Kraus et al. by delivering the same consequences for precursors as those in effect during the pre-training baseline condition. That is, there were no programmed consequences (i.e., no reinforcement or modeling) in effect for precursors in the post-training condition. By conducting this procedural refinement, Beaulieu et al. (2012) assessed whether teaching compliance resulted in subsequent maintenance of precursors and increases in compliance when the intervention for precursors was no longer in effect. Similar to Kraus et al. (2012), the training of precursors increased compliance in the absence of direct intervention for all 12 participants. However, the precursors did not maintain during post-training.

Since the publication of Beaulieu et al. (2012), additional research has extended the generality of this approach across various procedural refinements. For example, similar outcomes have been obtained when preschoolers were trained to prompt and reinforce one

another's precursors (Beaulieu et al., 2013; Beaulieu & Hanley, 2014). Another variation involved teaching preschool teachers, rather than researchers, to implement the intervention and assessing whether training precursors increases compliance when more complex instructions, such as a response chain (e.g., "get your pencil from your cubby and bring it to the table"), were used (Beaulieu & Hanley, 2014). Consistent with previous research, compliance during post-training conditions increased for all participants.

Although this intervention has generality across several procedural variations with typically developing preschoolers (Beaulieu et al., 2012; Beaulieu et al., 2013; Beaulieu & Hanley, 2014; Kraus et al., 2012), it remains unknown if this approach would be effective with individuals with intellectual disabilities (ID). Extending the generality of training precursors to improve compliance to individuals with ID would be beneficial because the intervention concurrently addresses two recommended goals of therapeutic services for this population: increasing attending and compliance (Ahearn et al., 2007; Rehfeldt & Rosales, 2007). To further enhance outcomes of therapeutic services for individuals with ID, it would be beneficial to assess the generality of this intervention to a different instructional format. Previous research only evaluated the effects of increasing precursors on compliance with one set of instructions delivered during child-led structured play activities. However, individuals with ID are often taught multiple skills in teacher-led instructional formats, such as discrete trial teaching (Schreibman, 2005). If prompting and reinforcing precursors results in improved compliance during discrete-trial teaching, and that compliance improves across more than one teaching target, then this intervention offers an efficient method for teaching the wide range of skills presented to individuals with ID during therapeutic services.

The generality of this approach to telehealth instruction also remains unknown as previous research has been conducted during in-person sessions only (Beaulieu et al., 2012; Beaulieu et al., 2013; Beaulieu & Hanley, 2014; Kraus et al., 2012). Telehealth is a commonly used format for delivering therapeutic services (Ferguson et al., 2019) and has been used to directly teach skills to individuals with ID (e.g., Boutain et al., 2020; Pellegrino and DiGennaro Reed, 2020). However, practitioners report a variety of challenges when teaching remotely, including difficulty viewing clients (e.g., if they moved away from the screen), disruptions in the home environment (e.g., siblings entering the session space and distracting the client), and difficulty vocally prompting caregivers to implement necessary components of an intervention or instructional session (Lerman et al., 2020). It is possible that increasing precursors to compliance could reduce the impact of these variables by ensuring the client remains in view of the camera, attends to instruction, and refrains from engaging in competing behavior.

The purpose of the current study was to assess the generality of increasing precursors to increase compliance in three ways. First, we conducted the intervention with four individuals diagnosed with autism spectrum disorder (ASD). Second, we evaluated the generality of this intervention by measuring compliance across two instructional tasks delivered in a teacher-led instructional format (i.e., discrete trial teaching). Finally, we assessed the generality of this approach by conducting the intervention remotely for two of four participants. Two additional procedural refinements were implemented to accommodate the new population and teaching format. First, we used physical prompts paired with reinforcement (rather than BST) to train precursors because these procedures are empirically supported methods for increasing behavior that might be classified as precursors in individuals with ID (e.g., eye contact; Carbone et al., 2013; Cook et al., 2017; Ferritor et al., 1972; Ninci et al., 2013; Walker & Buckley, 1968).

Second, we trained a modified set of precursors (i.e., sitting, orienting, eye contact, observing response; sitting and observing response were included in lieu of stopping and saying "yes") to accommodate the teacher-led instructional format.

Method

Participants and Settings

Four individuals diagnosed with an autism spectrum disorder (ASD) participated. All participants attended a center-based day program for individuals with autism and related disabilities. They were referred for participation by their clinical team due to a history of low-to-moderate levels of compliance during in-person or remotely delivered discrete trial instruction.

Aaron and Archie participated in the study through in-person sessions. Aaron was 10-years old and communicated using vocal approximations and Picture Exchange Communication (PECs). Aaron would often push or turn his chair away from his desk, look away from program materials, or engage in interfering motor and vocal stereotypy during instructional sessions. Archie was a 12-year-old boy who communicated via one-word to full-sentence vocalizations. He had a history of leaving his seat, looking away from program materials, and engaging in interfering motor stereotypy during instruction. Sessions were conducted in classrooms either in a partitioned cubby space equipped with a table and two chairs (Aaron) or at a table in the center of the classroom (Archie). The first author served as the primary therapist for all in-person sessions.

Ryan and Eddie participated remotely and were nominated by their clinical teams following difficulty with compliance with instructions delivered via telehealth. Ryan was an 11-year-old boy who communicated via an AAC device, vocal approximations, and signing. He had a history of engaging in off-task behavior during in-person and telehealth instruction, which

included walking away from his work area, engaging with distracting materials (e.g., toys) in the environment, engaging in motor and vocal stereotypy, and closing his eyes. Eddie was an 11-year-old boy who communicated via one-word to full-sentence vocalizations and an AAC device. During telehealth instruction, Eddie often looked away from instructional materials, tipped back in his chair, laid his head down on the table, or engaged in interfering motor and vocal stereotypy. Remote sessions were conducted from a quiet area of the first or second author's homes. All sessions were conducted via the Zoom Video Communications® platform. The therapists joined via laptop computers using a wireless internet connection. Participants joined from their homes via an iPad®, iPhone®, or laptop computers and wireless internet connection. Ryan joined from a table in his family's kitchen and his mother assisted with prompting and reinforcement across all sessions. Eddie joined from a table in his playroom, dining room, or family kitchen. Eddie's father or mother assisted with prompting and reinforcement.

Pre-Assessments

Identification of Preferred Stimuli

The therapist asked the participants' clinical team (Aaron and Archie) or caregivers (Ryan and Eddie) to nominate the participants' most preferred item that could be delivered in person (e.g., edibles, toys, books, physical attention) or remotely (e.g., songs, videos, computer games). Clinicians and/or caregivers were asked to indicate the stimulus category (i.e., tangibles, edibles, attention) they thought would be most likely to include an effective reinforcer. Items in the nominated category were subsequently evaluated in a preference assessment. Aaron and Archie's clinical teams nominated edibles as the category most likely to contain an effective reinforcer. Salt and vinegar chips, Goldfish, Skittles, and pretzels were evaluated for Aaron.

PopChips, Veggie Chips, potato chips, and Pirate's Booty were evaluated for Archie. Ryan and Eddie's caregivers nominated tangible items as the category that most likely contained an effective reinforcer. Blocks, trains, and videos on an iPhone were included in the preference assessment for Ryan. Videos on a computer screen of airplanes landing and taking off, Disney songs, soccer players making goals, and luxury cars were included in the preference assessment for Eddie.

Nominated items were evaluated in paired stimulus preference assessments (based on procedures described by Fisher et al., 1992) conducted by either the first author (Aaron, Archie, and Eddie) or the participant's caregiver (Ryan). For Aaron and Archie, the therapist presented edible items in person. Ryan's mother followed live therapist-delivered instructions to present tangibles to Ryan. Instructions included which materials to present on each trial, how to present the materials, how to respond to Ryan's selection, and where to store materials between trials. The therapist also provided Ryan's caregiver with a data sheet depicting which items to present on each trial and in which position (left or right). For Eddie, the first author presented video choices remotely by projecting side-by-side pictorial representations of each option onto the screen and describing his choices for a given trial (e.g., "do you want airplane or car videos?" or "do you want Disney® songs or nothing [control]?").

During each preference assessment, the nominated items plus one control item (blank card) were evaluated. Each item was paired with every other item twice, once in the left position and once in the right position, for a total of 8 presentations per item, and a total of 20 trials per assessment. During each trial, the therapist or caregiver presented two items simultaneously and equidistant from the participant. Participant access to the items were blocked until the trial began. To start the trial, the therapist or caregiver stated, "pick one" (Aaron, Archie, and Ryan)

or narrated the choices (Eddie) and allowed the participant 3 to 5 s to make a choice. Selection of an item, defined as pointing to or vocally naming the item, resulted in removal of the other item (Aaron, Archie, and Ryan) or removal of the images on the screen (Eddie) and 30 s access to the selected item. Selection of the control card resulted in 30 s access to nothing. No selection within 3 to 5 s resulted in removal of the materials, a brief pause, and representation of the trial. If the participant did not select an item on the representation, no response was recorded, and the next trial was presented. The therapist or caregiver blocked attempts to select both items; if this occurred, the trial was represented. The therapist collected data on selection and calculated percentage selection for each item by dividing the number trials in which that item was selected by the number of opportunities that it was presented (8) and multiplying that number by 100%. The two most selected items were used throughout the remainder of the study and included salt and vinegar chips and Goldfish (Aaron), PopChips and Veggie Chips (Archie), blocks and videos on the iPhone (Ryan), and airplane videos and Disney songs (Eddie).

Task Identification

Instructional tasks for inclusion in the intervention were selected based on a brief, informal interview with the participants' clinical team. Clinicians were asked to identify two tasks from the participant's current or most recently completed individualized education plans (IEP) that (1) required attending to visual stimuli and (2) that the participant could complete but did not often comply with during in-person or remote instruction. The primary author conducted visual inspection of skill acquisition graphs for the identified tasks to ensure that the latter criterion was met. Two visual-visual match-to-sample tasks were identified for Aaron and Ryan, two auditory-visual match-to-sample tasks were identified for Archie, and a time telling task and a following written instructions task were identified for Eddie.

Materials

All materials for both in-person and remote sessions were presented via PowerPoint slideshows. A total of three slideshows were created for each participant and included two PowerPoints depicting task materials and one PowerPoint for training precursors. Each of the two tasks were presented in their own PowerPoint, and these slideshows were used during all conditions except the prompting and reinforcement (precursors) condition. Figure 1 depicts sample task slideshows. The 27-Slide PowerPoints were used for Archie, Ryan, and Eddie, and the 36-Slide PowerPoints were used for Aaron. The 36-Slide PowerPoint was used for Aaron because presentation of stimuli in a delayed-match-to-sample format most closely approximated how materials were presented to him during his regular in-person instruction. For all participants, each slideshow consisted of precursor slides (nine), trial slides (nine for Archie, Ryan, and Eddie who experienced one slide per trial; 18 for Aaron who experienced two slides per trial), and intertrial slides (nine). Precursor slides (blank, white) were presented as a signal for the initiation of a new trial and the emission of the four target precursors. Trial slides displayed stimuli associated with the task on a white background. For each trial for Aaron, two slides were presented in succession; the first slide contained the sample stimulus, and the second slide contained the comparison array (see the 36-Slide PowerPoint in Figure 1 for an illustration). For Ryan's match-to-sample tasks, a single slide with the sample stimulus on the top half of the slide and the comparison stimuli on the bottom half of the slide (see the 27-Slide PowerPoint in Figure 1 for an illustration) was presented on each trial. This arrangement of stimuli was selected for Ryan because his clinical team presented programming to him in this format during telehealth sessions. For both Aaron and Ryan, one of three sample stimuli was presented on each trial in a quasi-random order, with each stimulus presented a total of three times. The order of comparison

stimuli in the array also rotated across trials. For Archie and Eddie, one task slide was presented during each trial. These trial slides contained an array of three images (i.e., objects or numbers for Archie, analog clocks for Eddie's time telling task) or one line of printed instructions (for Eddie's following written instructions task). The order of stimuli in the array was rotated across trials. Intertrial slides (blank grey) were presented for 30 s following each trial slide(s) and were used to signal the end of the opportunity to comply and time for consequence consumption (reinforcer for compliance or no reinforcement for incorrect or no response).

The third PowerPoint created for each participant was used during the prompting and reinforcement (precursors) condition only. This slideshow consisted of 18 slides; nine precursor slides and nine intertrial slides (i.e., no trial slides were presented). The precursor slides and the intertrial slides were identical to those described for task PowerPoints.

Response Measurement

During all conditions except the prompting and reinforcement (precursors) condition, data were collected on the occurrence or non-occurrence of four precursors and compliance. During the prompting and reinforcement (precursors) condition, the experimenter collected data on the occurrence and non-occurrence of precursors only because there was no opportunity for compliance (i.e., the task was not presented during these sessions). For all conditions, data for each response were converted into percentage of trials within a session by dividing the total number of occurrences of each target response by 9 (the total number of trials per session) and multiplying by 100.

Across all conditions, observers recorded the four precursor responses only when the precursor slides were displayed on the screen; if the participant emitted precursors during the subsequent PowerPoint slides, then those precursors were not scored. The four precursors

included sitting, orienting, eye contact, and observing response. *Sitting* was defined as the participant placing their buttocks on a chair with their feet on the floor (scored for in-person participants only) and the trunk of their body in upright position in the absence of gross motor body movements of the trunk, arms, or legs for 5 consecutive seconds. *Orienting* was defined as the participant positioning their body so that the trunk of their body made less than a 45-degree angle with the screen for 5 consecutive seconds. *Eye contact* was defined as the participant having both eyes open with their gaze directed toward the experimenter's eyes (Aaron and Archie) or the screen (Ryan and Eddie) for at least 1 second. *Observing response* was defined as the participant touching the blank screen (Ryan) or emitting a vocal statement of readiness (i.e., "yes" for Aaron and "ready" for Archie and Eddie).

Compliance was scored only when the trial slide (or second trial slide for Aaron) was presented and was defined as the participant emitting the correct response within 10 s of the initiation of the trial slide. Correct responses were defined individually based on the selected task. Aaron's tasks were visual-visual match-to-sample tasks that required him to match a sample picture of common objects (e.g., cup, ball, boat) to the identical comparison picture in an array of three pictures; therefore, compliance was scored when he pointed to the comparison stimulus that matched the sample picture presented by the therapist. Archie's tasks were auditory-visual match-to-sample tasks that required him to listen to the therapist name a common object or number (e.g., fork, spoon, 1, 2, 3) and indicate the corresponding picture or number from an array of three stimuli; therefore, compliance was scored if he pointed to the stimulus that corresponded with the object or number named by the therapist. Like Aaron, Ryan's tasks were visual-visual match-to-sample tasks; compliance was scored for Ryan when he pointed to the comparison stimulus in the three-stimulus array that matched the sample picture presented by the

therapist. Eddie's first task was a time telling task that required him to listen to the therapist state a whole-hour time (e.g., "5 o'clock") and indicate the corresponding image of an analog from an array of three clocks; therefore, compliance was scored if he pointed to the clock that corresponded with the time named by the therapist. Eddie's second task was a following written directions task that required him to read a description of two simple motor actions (e.g., "tap table and clap hands") and emit both motor actions. Compliance for this task was scored if Eddie emitted the two actions (e.g., tapping the table and clapping his hands) that corresponded with the written direction; if Eddie emitted any action that was not written in the direction (e.g., touched his ear), compliance was not scored.

Interobserver Agreement

Interobserver agreement (IOA) was collected by having a secondary observer score the occurrence or nonoccurrence of each target response per trial for at least 33% of all sessions. IOA was calculated for each response using trial-by-trial agreement by diving the total number of agreements (0 for a disagreement, 1 for an agreement) by the total number of trials per session (9) and multiplying this number by 100%. For Aaron, IOA was collected in 33.3% of sessions, and the mean was 99.1% (range, 77.8% to 100%) for sitting, 97.8% (range, 77.8% to 100%) for orienting, 99.1% (range, 88.9% to 100%) for eye contact, 97.8% (range, 77.8% to 100%) for observing response, and 99.5% (range, 88.9% to 100%) for compliance. For Archie, IOA was collected in 34.6% of sessions, and the mean was 94.4% (range, 77.8% to 100%) for sitting, 98.8% (range, 88.9% to 100%) for orienting, 96.3% (range, 77.8% to 100%) for eye contact, 98.8% (range, 88.9% to 100%) for observing response, and 100% for compliance. For Ryan, IOA was collected in 34.3% of sessions, and the mean was 97.2% (range, 77.8% to 100%) for sitting, 98.1% (range, 77.8% to 100%) for orienting, 90.7% (range, 77.8% to 100%) for eye

contact, 96.3% (range, 77.8% to 100%) for observing response, and 95.6% (range, 77.8% to 100%) for compliance. For Eddie, IOA was collected in 35.1% of sessions, and the mean was 93.2% (range, 66.7% to 100%) for sitting, 99.1% (range, 88.9% to 100%) for orienting, 78.6% (range, 55.6% to 100%) for eye contact, 97.4% (range, 77.8% to 100%) for observing response, and 98.0% (range, 88.9% to 100%) for compliance.

Experimental Design

The effects of training precursors on compliance were evaluated in a multiple baseline across tasks design for Aaron and Archie. For Ryan and Eddie, a multiple baseline across participants design was used. For all participants, a pre-training baseline condition for the first task was conducted to determine pre-intervention levels of precursors and compliance. The first training condition, prompting and reinforcement (precursors), was conducted until criterion performance was met (i.e., the participant emitted all four precursors on at least 7 of 9 (78%) of trials for three consecutive sessions). This criterion was selected because previous research in this area used a criterion of 80% based on stakeholder (i.e., the participant's preschool teachers) input (e.g., Kraus et al., 2012). Once this criterion was met, a post-training baseline condition was conducted to evaluate the effects of the newly acquired precursors on compliance. The performance criterion for completion of training was compliance on at least 78% of trials for three consecutive sessions. If the participant met this criterion, then no further training sessions were conducted with that task. If the performance criterion was not met, then direct teaching of compliance was conducted via the prompting and reinforcement (precursors and compliance) condition until the participant complied on at least 78% of trials for three consecutive sessions.

Compliance with a second task was also evaluated for each participant. Sessions for the second task were conducted in a 3:1 ratio such that a session for the second task was conducted

following every three sessions for the first task. The second task remained in baseline until the participant showed mastery criterion for compliance with the first task (i.e., 78% of trials for three consecutive sessions). If this criterion was not met, then the teaching condition that was effective with the participant's first task was conducted with the second task (Aaron and Archie). If the participant met criterion performance (i.e., 78% of trials for three consecutive sessions) with the second task during the baseline condition, then implementation of a teaching condition was not needed, and the training analysis was complete (Ryan and Eddie).

Procedures

At the beginning of each session, the therapist offered the participants a choice between the two most selected reinforcers identified in the preference assessment. For Aaron and Archie, this choice consisted of the therapist holding up both edible options and stating, "which do you want to earn?" Ryan's caregiver showed him blocks and an iPhone and asked him to select which one he wanted to earn. The therapist showed Eddie a PowerPoint slide depicting a United Airlines plane and screenshots from Disney songs and stated, "do you want to earn airplane videos or songs?"

All sessions consisted of nine trials. Across all conditions, each trial began with the presentation of a precursor slide and the therapist stating, "[participant's name], ready?" During the baseline and prompting and reinforcement (precursors and compliance) conditions, the precursor slide was followed by one (Archie, Ryan, and Eddie) or two (Aaron) trial slide(s), followed by one intertrial slide. During the prompting and reinforcement (precursors) condition, one trial was composed of the presentation of the precursor slide (as described above), followed by one intertrial slide. Condition-specific procedures during the presentation of each of these slides are described below.

Pre- and Post-Training Baseline

The therapist used the PowerPoints depicting task materials (i.e., the PowerPoint containing precursor slides, trial slides, and intertrial slides) during this condition. During each trial, the precursor slide remained on the screen for 10 s or until the participant emitted all four precursors, whichever came first. No prompts to emit precursors or programmed consequences for the occurrence or nonoccurrence of precursors were delivered. Next, the experimenter advanced the slideshow to the trial slide while presenting a task-specific instruction (e.g., "match" for Aaron and Ryan's visual-visual match-to-sample tasks, "cup" for Archie's visual-visual match-to-sample tasks, "follow the direction" for Eddie's following two-step written instructions tasks, or "5 o'clock" for Eddie's time telling task). No further instructions or prompts for compliance were presented. If the participant complied within 10 s of the initiation of the trial slide, then the therapists delivered descriptive praise (e.g., "that's matching the ball!"), progressed the PowerPoint to the intertrial slide, and delivered 30-s access to the selected preferred stimulus. Edibles were provided approximately every 5-10 s during this reinforcement interval for Aaron and Archie. If the participant did not comply within 10 s or responded incorrectly, then the therapist advanced the slideshow to the intertrial slide without delivering praise or the highly preferred stimulus. Following the intertrial interval, the experimenters initiated the next trial by advancing the slideshow to the next precursor slide. This pattern of slide presentation (i.e., precursor slide, task slide, intertrial interval slide) was repeated until all 9 trials were presented.

Prompting and Reinforcement (Precursors)

Training of precursors involved prompting and reinforcement. During this condition, the therapists used the PowerPoint that consisted of only precursor and intertrial slides. No task trials

were presented; thus, there was no opportunity for compliance during this condition. The therapists delivered prompts for Aaron and Archie, and caregivers delivered prompts for Ryan and Eddie due to their remote participation. Prior to the start of each of Ryan and Eddie's sessions, the experimenters provided a description of the prompts (e.g., "you should prompt your child to sit by placing a hand on their shoulder and applying gentle downward pressure") and a reminder of when they should present prompts (i.e., following a 10 s delay and only if the precursors did not occur). The therapist also noted that they would provide a signal to the caregiver regarding when a prompt should be presented and for which responses. If inaccurate prompt presentation occurred, the therapist delivered in-vivo feedback to the caregiver. On the few occasions in which the caregiver presented a prompt incorrectly, it an error of commission (i.e., they presented prompts for precursors that had occurred independently).

As in baseline, each trial began with the therapists displaying the precursor slide and stating, "[participant's name] ready?" If the participant emitted all four precursors within 10 s, then the therapist issued descriptive praise (e.g., "that's showing me ready!"), progressed the slideshow to the intertrial slide, and delivered 30-s access to the selected preferred stimulus. If the participant did not emit all four precursors within 10 s, then the therapist or caregiver prompted the participant to emit the precursor(s) that were not emitted. The topography of the prompt differed depending on which precursor was being taught. For *sitting*, the therapist or caregiver physically guided the participant to sit by gently placing a hand on his shoulder and applying light downward pressure. For *orienting* and *eye contact*, the therapist or caregiver provided light physical guidance to the participant's shoulders (orienting) or head (eye contact) and guided the participant's torso or head in the direction of the screen. For all participants except Ryan, a vocal prompt in the form of a statement of the *observing response* (i.e., "yes" or

"ready") was presented on a fixed-time 5 s schedule until the participant echoed the response. For Ryan, physical guidance (i.e., lightly guiding the participant by the forearm to touch the screen) was used. Once the participant emitted all precursors (prompted or independent), the therapist issued descriptive praise (e.g., "that's showing me ready!"), progressed the slideshow to the intertrial slide, and delivered 30-s access to the selected preferred stimulus. Following the intertrial interval, the therapists initiated the next trial by advancing to the next precursor slide. This pattern of slide presentation (i.e., precursor slide, followed by intertrial slide) was repeated for each of the nine trials.

Prompting and Reinforcement (Precursors and Compliance; Aaron and Archie)

If the participant's level of compliance did not meet the performance criterion of 78% for three consecutive sessions in the second baseline condition, then the prompting and reinforcement procedure was extended to include compliance as well as precursors. The therapist used the PowerPoints depicting task materials (i.e., the PowerPoint containing precursor slides, trial slides, and intertrial slides) during this condition. As in previous conditions, the first slide presented during each trial was the precursor slide. When this slide was presented, the therapist stated, "[participant's name] ready?" If the participant emitted all four precursors within 10 s, the therapist advanced to the trial slide(s) and issued a task-specific instruction as described above for the pre- and post-training baseline conditions. If the participant did not emit all four precursors within 10 s, prompting to emit the omitted precursors was initiated as described in the previous training condition, prompting and reinforcement (precursors). Once the participant emitted all precursors (prompted or independent), the therapist advanced to the trial slide and issued a task-specific instruction as described in the pre- and post-training baseline conditions. If the participant complied within 10 s of the initiation of the trial slide, then the therapist delivered

descriptive praise (e.g., “that’s matching the ball!”), advanced to the intertrial slide, and provided the 30-s reinforcement interval as described in previous conditions. If the participant did not comply within 10 s of the initiation of the trial slide or if the participant responded incorrectly, then the therapist prompted the participant to comply using light physical guidance at the participants’ forearm. Prompted compliance, regardless of whether the participants made an initial error, resulted in descriptive praise (e.g., “that’s matching the ball!”), and the therapist progressing to the intertrial slide and providing the preferred stimulus for 30 s as described in previous phases. This pattern of slide presentation (i.e., precursor slide, trial slide(s), intertrial slide) repeated for each of the nine trials.

Results

Figure 2 depicts Aaron’s precursors (top panel) and compliance (second panel) with the first task. During the pre-training baseline, Aaron emitted three precursors (sitting, orienting, and eye contact) at moderate-to-high levels and one precursor (observing response) at low levels. However, all precursors and compliance (M = 29.6%) were below the performance criterion of 78% occurrence for three consecutive sessions. During the prompting and reinforcement (precursors) condition, Aaron met the performance criterion for sitting, orienting, and eye contact within the first few sessions, whereas the observing response required eight sessions before the performance criterion was met. During the post-training baseline, Aaron continued to emit all four precursors at or above the performance criterion. However, compliance remained low (M = 33%), suggesting that strengthening precursors was not sufficient to increase Aaron’s compliance. When the prompting and reinforcement (precursors and compliance) condition was implemented, Aaron continued to emit all four precursors at criterion levels. However, Aaron’s compliance became variable and did not increase to criterion levels. Because it was hypothesized

that Aaron learned he received reinforcement more quickly following an error, starting in session 33, the therapist began withholding reinforcement following errors. More specifically, if Aaron made an error (i.e., pointed to an incorrect stimulus in the comparison array), then the therapist physically guided Aaron to emit the correct response, provided descriptive praise (e.g., "that's matching the ball"), progressed to the intertrial slide, and withheld during the 30-s intertrial interval. When this modification was made, Aaron's independent compliance decreased. Therefore, a second modification was initiated at session 49. This modification involved delivering reinforcement for only independent occurrences of compliance. If independent compliance did not occur (i.e., the participant did not respond within 10 s) or if Aaron made an error, then the therapist prompted Aaron to comply, provided descriptive praise (e.g., "that's matching the ball!"), advanced to the intertrial slide, and withheld reinforcement during the 30-s intertrial interval. Following this modification, Aaron's compliance increased to moderate levels and met the performance criterion of 78% for three consecutive sessions at session 66 (after 17 sessions). These data suggest that prompting and reinforcement of only precursors was not sufficient to increase compliance; direct teaching of compliance was necessary.

Figure 2 depicts Aaron's precursors (third panel) and compliance (fourth panel) with his second task. During the first several baseline sessions, Aaron emitted all four precursors at moderate levels but below the mastery criterion of 78% occurrence for three consecutive sessions. By session 24 of baseline, when prompting and reinforcement (precursors and compliance) was initiated for Aaron's first task, he met mastery criterion for all four precursors. Precursors remained high for the remainder of baseline sessions, except for session 52 in which Aaron emitted the observing response in only 44.4% of trials. Aaron emitted stable and low levels of compliance (M = 38.9%) throughout baseline despite increases in precursors. These

findings provide further support that increasing precursors was not sufficient for increasing Aaron's compliance. When the modified prompting and reinforcement (precursors and compliance) was initiated with the second task, all four precursors remained at criterion levels and compliance met mastery criterion within seven sessions, replicating the effect of prompting and reinforcement (precursors and compliance) on compliance with the first task.

Figure 3 depict Archie's precursors (top panel) and compliance (second panel) with his first task. During the pre-training baseline, Archie emitted three precursors (sitting, eye contact, observing response) at low levels and one precursor (orienting) at variable but overall low levels. All precursors occurred below the mastery performance criterion of 78% occurrence for three consecutive sessions, and Archie did not comply with the instruction during baseline. During the prompting and reinforcement (precursors) condition, Archie met the performance criterion for all precursors within six sessions. During the post-training baseline, unlike Aaron, Archie's levels of all precursors decreased to below mastery criterion in the second session. Similar to Aaron, Archie's compliance remained below mastery criterion. To rule out the possibility that compliance did not increase because precursors did not maintain, we reimplemented the prompting and reinforcement (precursors) condition, and Archie's precursors increased to the performance criterion within three sessions. However, during the subsequent post-training baseline, all precursors decreased again to below mastery criterion, and Archie's compliance remained at zero. These findings replicate Aaron's and suggest that strengthening precursors was not sufficient to increase Archie's compliance. When the prompting and reinforcement (precursors and compliance) condition was implemented, precursors increased but remained below the mastery criterion (M for sitting = 83.4%, M for orienting = 88.9%, M for eye contact = 94.5%, M for observing response = 81.5%). Archie's compliance increased to mastery criterion

within four sessions and remained high for the remainder of the phase. Similar to Aaron, these data suggest that direct teaching of compliance was necessary to increase Archie's compliance.

Figure 3 depicts Archie's precursors (third panel) and compliance (bottom panel) with his second task. During the first several baseline sessions, Archie emitted all precursors at low levels and below the mastery criterion of 78% occurrence for three sessions. Between sessions 16 and 24, precursors increased and orienting met criterion performance. For the remainder of the condition, all four precursors decreased. No compliance occurred during baseline with the second task. When prompting and reinforcement (precursors and compliance) was initiated, three precursors (sitting, orienting, eye contact) increased to criterion levels within six sessions; observing response increased but did not meet the mastery criterion (M = 75.6%). Compliance increased to the performance criterion within three sessions, replicating the effect of prompting and reinforcement (precursors and compliance) on compliance with the first task.

Figure 4 depicts Ryan and Eddie's precursors and compliance for their first tasks. The top two panels depict Ryan's precursors (sitting, orienting, eye contact, observing response) and compliance, respectively. During the pre-training baseline, Ryan emitted sitting and orienting at the performance criterion, whereas eye contact and observing response occurred at moderate and low levels, respectively. Ryan complied with the task at moderate levels (Mean = 57.8%). During the prompting and reinforcement (precursors) condition, sitting and orienting maintained above criterion levels; eye contact and observing response increased to the performance criterion within six sessions. During the post-training baseline, Ryan's sitting and orienting maintained at or above performance criterion. However, eye contact and observing response decreased below the mastery criterion. Despite decreases in two precursors, Ryan's compliance increased and met mastery criterion during the first three sessions. After increasing to criterion levels, compliance

decreased to moderate levels for several sessions before returning to criterion levels in the last four sessions. There was a three-week break between the third and fourth sessions that may have contributed to this variability. These data suggest that, unlike Aaron and Archie, prompting and reinforcement (precursors) was sufficient to increase Ryan's compliance, and this effect maintained in a follow-up conducted after one month.

Eddie's precursors and compliance with the first task are depicted in the third and fourth panels of Figure 4, respectively. During pre-training baseline, Eddie emitted one precursor (orienting) at the performance criterion, two precursors (sitting and eye contact) at moderate levels, and one precursor (observing response) at low levels. Eddie complied with the task at moderate levels (M = 49.2% of trials). During the prompting and reinforcement (precursors) condition, orienting maintained above criterion levels. Sitting, eye contact, and observing response increased to the performance criterion within three, 14, and 14 sessions, respectively. During the post-training baseline, sitting and orienting maintained at or above the performance criterion, whereas eye contact and observing response did not. Despite decreases in two precursors, Eddie's compliance increased to the mastery criterion within four sessions, replicating the effect obtained with Ryan and showing that prompting and reinforcement (precursors) was sufficient to increase Eddie's compliance. During a follow-up conducted after one month, two precursors (sitting and orienting) maintained at the performance criterion, whereas eye contact and observing response occurred at low levels. In addition, Eddie's compliance decreased below mastery criterion (66.7%) but remained above baseline levels.

Figure 5 depicts Ryan's precursors and compliance for his first task (top two panels; identical to the top two panels of Figure 4) and his second task (bottom two panels). During baseline for the second task, sitting and orienting occurred at high levels and met criterion; eye

contact occurred at moderate-to-high levels but did not meet criterion, and observing response remained low. Although only two of the four precursors occurred at performance criterion levels, compliance with the second task increased to the mastery criterion by session 28, suggesting that strengthening precursors improved compliance with a second set of instructions. As with his first task, Ryan's performance maintained during follow-up conducted after one month despite moderate or low levels of two precursors (eye contact and observing response).

Figure 6 depicts Eddie's precursors and compliance for his first task (top two panels; identical to the top two panels of Figure 4) and his second task (bottom two panels). During baseline for his second task, Eddie emitted orienting and sitting at high levels that met the performance criterion. Orienting remained above criterion performance throughout the condition and sitting increased and met criterion by session 20. Eye contact and observing response increased but did not meet the performance criterion. Although two precursors (eye contact and observing response) did not meet performance criterion, Eddie's compliance with the second task met mastery criterion by session 20, replicating the effect that strengthening precursors improved compliance with a second set of instructions. As with his first task, Eddie's performance maintained during a follow-up conducted after one month despite moderate-to-low levels of two precursors (eye contact and observing response).

Discussion

The purpose of the present study was to assess the generality of Kraus et al. (2012), Beaulieu et al. (2012), Beaulieu et al. (2013), and Beaulieu and Hanley (2014) by evaluating the effects of increasing precursors on compliance with two tasks in individuals with ID during teacher-led instruction (i.e., discrete trial teaching). Prompting and reinforcement were used to teach four participants to emit precursors (sitting, orienting, eye contact, and observing response)

in response to the cue "[participant's name], ready?" prior to delivering instructions from their individualized education plans. In addition, for two of the four participants, this intervention was evaluated when instructions were presented via telehealth. Two main outcomes were observed across the four participants. For Aaron and Archie, prompting and reinforcing precursors was not sufficient to increase compliance. For Ryan and Eddie, prompting and reinforcing precursors was sufficient to increase compliance across two discrete trial tasks presented via telehealth.

The finding that prompting and reinforcement of precursors was sufficient to increase compliance replicates the results of Kraus et al. (2012), Beaulieu et al. (2012), Beaulieu et al. (2013), and Beaulieu and Hanley (2014) and extends the generality of the intervention to individuals with ID, and multiple instructions in a discrete-trial teaching format. In addition, because this outcome was observed with the two participants (Ryan and Eddie) who received instructions via telehealth, these results suggest that this intervention can be effective when delivered remotely. These findings are encouraging as they provide a cost-effective strategy in which clinicians can use one intervention to target two socially meaningful responses (i.e., attending and compliance) across multiple instructions. However, it is important to note that Ryan and Eddie's precursors did not maintain in the post-training baseline. This finding is consistent with that of Beaulieu et al. (2012) who found that precursors did not maintain when all intervention components were removed. Because the precursor behavior targeted in the current study have been recommended behavior for increase in individuals with ID (Ahearn et al., 2007; Rehfeldt & Rosales, 2007), future researchers should evaluate methods for maintaining precursors. It is possible that systematic thinning of the reinforcement schedule would result in improved maintenance of precursors. Alternatively, clinicians could intersperse training precursor sessions with baseline sessions. Beaulieu et al. (2013) found this strategy was effective

in promoting maintenance of precursors. Clinicians could adopt these procedures by conducting sessions of prompting and reinforcement (precursors) on a regular schedule (e.g., once per day).

The results obtained with Ryan and Eddie also extend the generality of this approach by demonstrating that teaching precursors can improve compliance with telehealth-delivered instructions. These findings are important because clinicians providing telehealth services noted challenges with keeping clients in view, environmental disruptions, and difficulty remotely coaching parents (Lerman et al., 2020). The procedures evaluated in this study addressed issues with keeping clients in view by reinforcing sitting in front of and orienting toward the screen. We also addressed the impact of environmental disruptions by reinforcing the occurrence of precursors during ongoing disruptions in the home setting (e.g., sibling entering the room, a grandparent cooking breakfast, the family dog barking). Finally, although difficulties with remote coaching of parents was not evaluated in the current study, the procedures used may have helped simplify caregiver involvement by reducing the number of responses they need to emit during training. By improving precursor behavior, caregivers assisting with telehealth sessions can allocate their time to the prompting and reinforcement of compliance with task instructions. Taken together, the intervention used in the current study may improve the efficacy of telehealth sessions.

Kraus et al. (2012) and Beaulieu et al. (2012) posited two potential reasons for why strengthening precursors improves compliance without direct intervention. First, they suggested that compliance is a chain of responses that includes precursors and compliance. Increasing precursors strengthens early parts of the response chain, thus making later parts of the response chain (i.e., compliance) more likely. Along similar lines, Beaulieu et al. (2012) suggested that precursors and compliance are members of the same response class. By reinforcing one member

of that response class (i.e., precursors), other members of the response class (i.e., compliance) may increase in strength. It is possible that either or both mechanisms of change operated in the current study with Ryan and Eddie. It is also possible that task-specific instructions did not function as discriminative stimuli for compliance during the initial baseline because the participants were engaging in interfering behavior (e.g., stereotypy). Establishing precursors may have reduced these interfering behavior and increased the likelihood that task-specific instructions functioned as discriminative stimuli for compliance. Future researchers could examine this possibility by comparing levels of interfering behavior (e.g., stereotypy) before, during, and after the intervention for increasing precursors.

Considering these potential mechanisms of change may explain why prompting and reinforcement (precursors) was not sufficient to increase compliance for Aaron and Archie. Anecdotally, Aaron engaged in high rates of interfering behavior (e.g., vocal and motor stereotypy) throughout the intervention. Although his precursors maintained in the post-training baseline, it is possible that they did not sufficiently compete with his stereotypy. Therefore, it is possible that the task-specific instructions did not function as discriminative stimuli for Aaron's compliance. For Archie, whose precursors did not maintain during the post-training baseline, these responses may not have been part of a response chain with compliance. As a result, occasioning precursors during the reimplementation of baseline did not occasion compliance.

Another explanation for why different outcomes were obtained across participants may be related to the history of the participants with respect to on-screen instruction. Ryan and Eddie had a history of remote instruction via slides on a screen. Aaron and Archie typically received instruction with paper stimuli. An on-screen instructional format was used for all participants to ensure consistency across in-person and remote participants. However, it is possible that

presenting a known academic task in a novel format impacted Aaron and Archie's compliance. We recommend that researchers replicate this intervention while assessing whether the format of instruction delivery affects the results with individuals with ID.

Replications of the current study with more participants may also allow researchers to further clarify the relation between precursors and compliance. Beaulieu et al. (2012) conducted a post-hoc statistical analysis of compliance occurring in the post-training condition to determine if one specific precursor or combination of precursors was predictive of compliance. They found that compliance was higher given the occurrence of at least one precursor and that the greater the number of precursors that occurred, the greater the likelihood of compliance. However, one specific precursor alone was not predictive of compliance. Results for Ryan and Eddie were consistent with those of Beaulieu et al. (2012) in that both participants emitted at least one precursor at criterion performance, resulting in improved compliance. Researchers could replicate the current study with a larger sample size and conduct post-hoc analyses similar to those conducted by Beaulieu et al. (2012) to further clarify the role of maintenance of precursors on compliance in individuals with ID.

A few limitations to the current study are worth noting. First, a functional analysis was not conducted to determine if the participants' low levels of compliance were a function of variables such as escape or attention. Although Rodriguez et al. (2013) and Majdalany et al. (2017) developed useful technologies for conducting functional analyses of low compliance, these methods were not used because our research question was related to a skill-based intervention for increasing compliance (i.e., prompting and reinforcing behavior that might occasion compliance). However, if an individual exhibits problem behavior (e.g., self-injury or aggression) that interferes with compliance during instructional sessions or if prompting and

reinforcement of precursors alone does not improve compliance, we recommend that clinicians conduct a functional analysis.

A second limitation was that a measure of social validity was not included in the current study. The social acceptability of these procedures has been evaluated in previous research. Kraus et al. (2012) developed this intervention in consultation with participants' teachers with the goal of developing methods that could be adopted into classroom routines. Beaulieu et al. (2012) and Beaulieu et al. (2013) obtained high scores of social validity from stakeholders (e.g., teachers, principal) on pre- and post-intervention ratings of acceptability of the target behavior, procedures, and outcomes. However, these findings are not a substitute for acceptability of the current study, especially given that the current study was conducted with a different population and involved caregiver participation for two participants (Ryan and Eddie). In future replications of the current study, researchers should conduct pre- and post-intervention measures of stakeholders' evaluation of the acceptability of selected precursors, the methods used, and the outcomes obtained. It would also be valuable to obtain input from relevant stakeholders on the goals for mastery. The mastery criterion of 78% occurrence for three consecutive sessions was based on previous research suggesting that 80% compliance was a socially appropriate goal (Kraus et al., 2012; Beaulieu et al., 2012; Beaulieu et al., 2013; Beaulieu and Hanley, 2014) and that 100% compliance is not a socially valid goal (Stephenson & Hanley, 2010). When replicating these procedures with individuals with ID, it would be helpful to assess the acceptability of the mastery criterion with relevant stakeholders.

A third limitation of the current study was that for three participants (Archie, Ryan, and Eddie), the two tasks evaluated were similar (e.g., two match-to-sample tasks for Archie and Ryan) or were not increasingly complex (e.g., both of Eddie's tasks could be completed while

seated and required only one or two simple actions). Beaulieu et al. (2014) demonstrated that typically developing preschoolers' compliance with tasks requiring multiple responses (e.g., get your pencil from your cubby and bring it to the table") improved following training of precursors. However, given the differences in the populations in Beaulieu et al. (2014) and the current study, it is recommended that these procedures be replicated with a wider range of instructions to further extend the generality of this approach. We suggest including tasks that involve chains of responses (e.g., tying a shoe) or responses that required the participant to move away from the table (e.g., obtain materials and bring them to the desk).

Despite these limitations, the current study suggests that, for some individuals with ID, increasing precursors can improve compliance without direct intervention. These results offer a promising and efficient strategy for improving two socially meaningful responses (i.e., attending and compliance) across more than one set of instructions. Based on the positive outcomes for Ryan and Eddie, who participated remotely, this intervention may be well suited for addressing challenges associated with telehealth instruction. This finding is encouraging, as improved compliance with telehealth may allow clients to access more services and learning opportunities (e.g., learning from online courses or videos). Although additional research is needed to further determine the generality of this approach with individuals with ID, this study provides support that precursors may be important initial skills to address at the outset of intervention to increase compliance.

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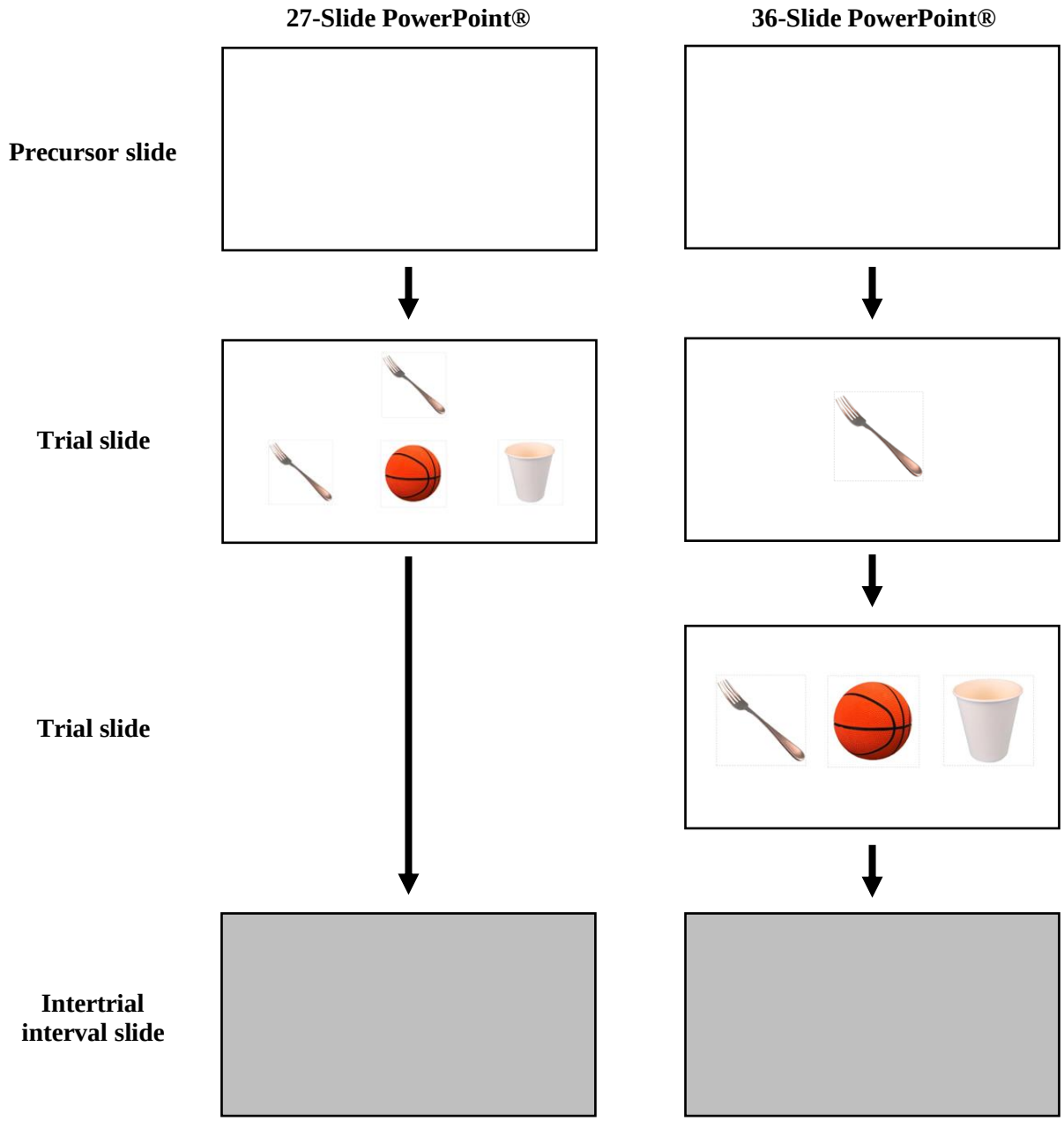
Figure 1.

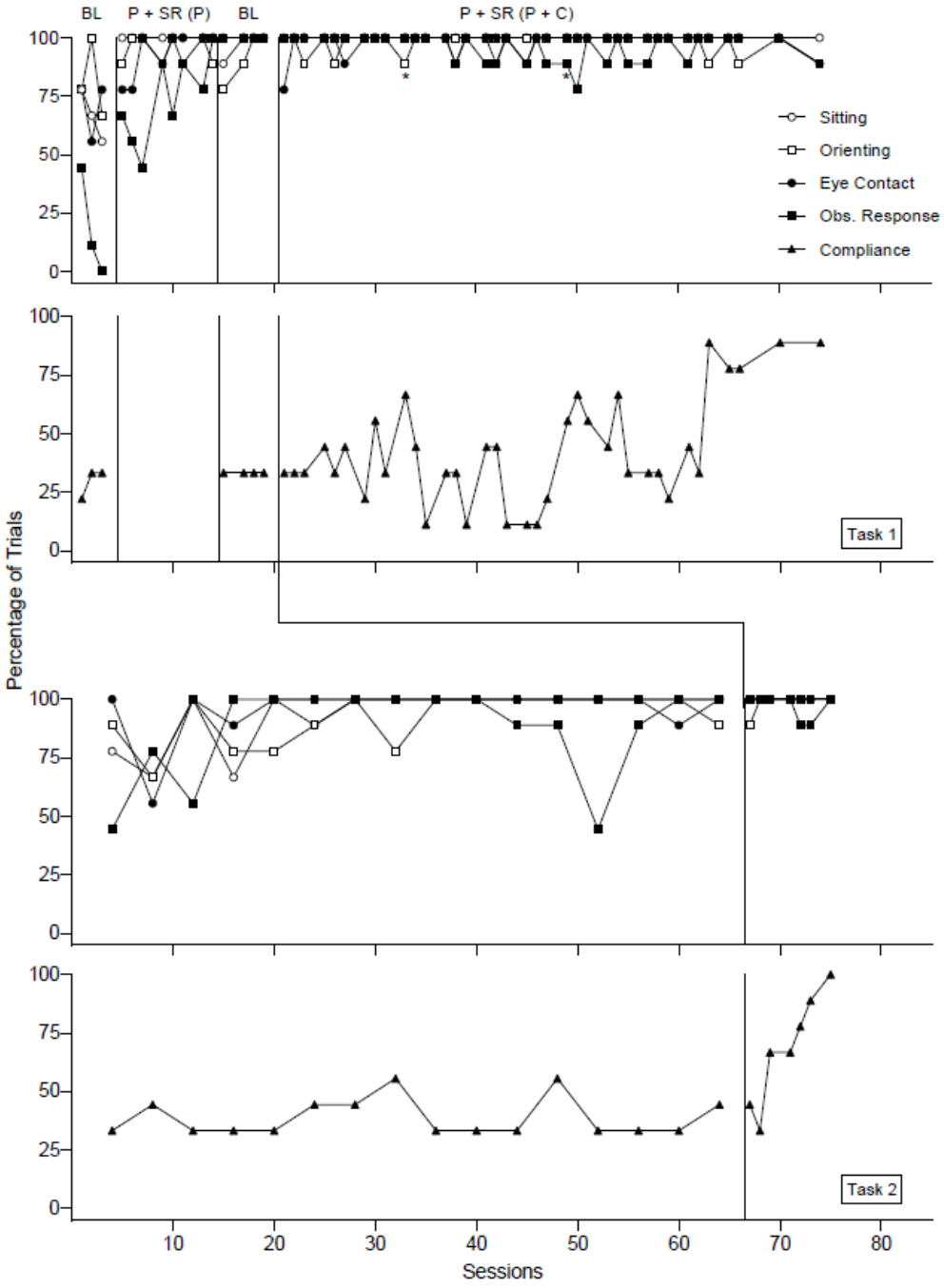
Sample PowerPoint® Slides



Note. Each set of slides composed one trial.

Figure 2

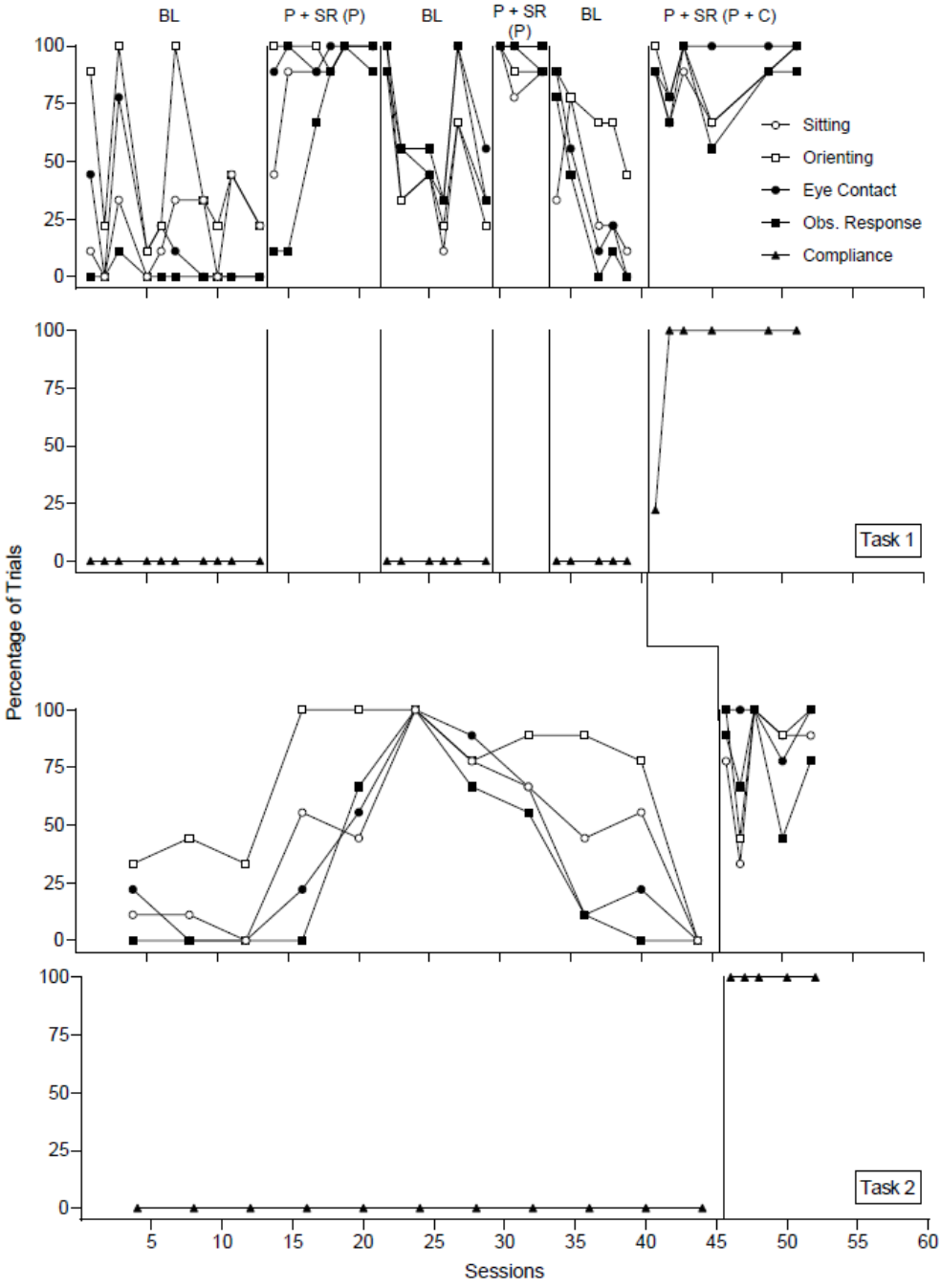
Percentage of Trials in Which Aaron Emitted Precursors and Compliance for Task 1 and Task 2



Note. BL = baseline, P+SR (P) = prompting and reinforcement (precursors), P+SR (P+C) = prompting and reinforcement (precursors and compliance), * denotes changes in reinforcement contingency at sessions 33 and 49

Figure 3

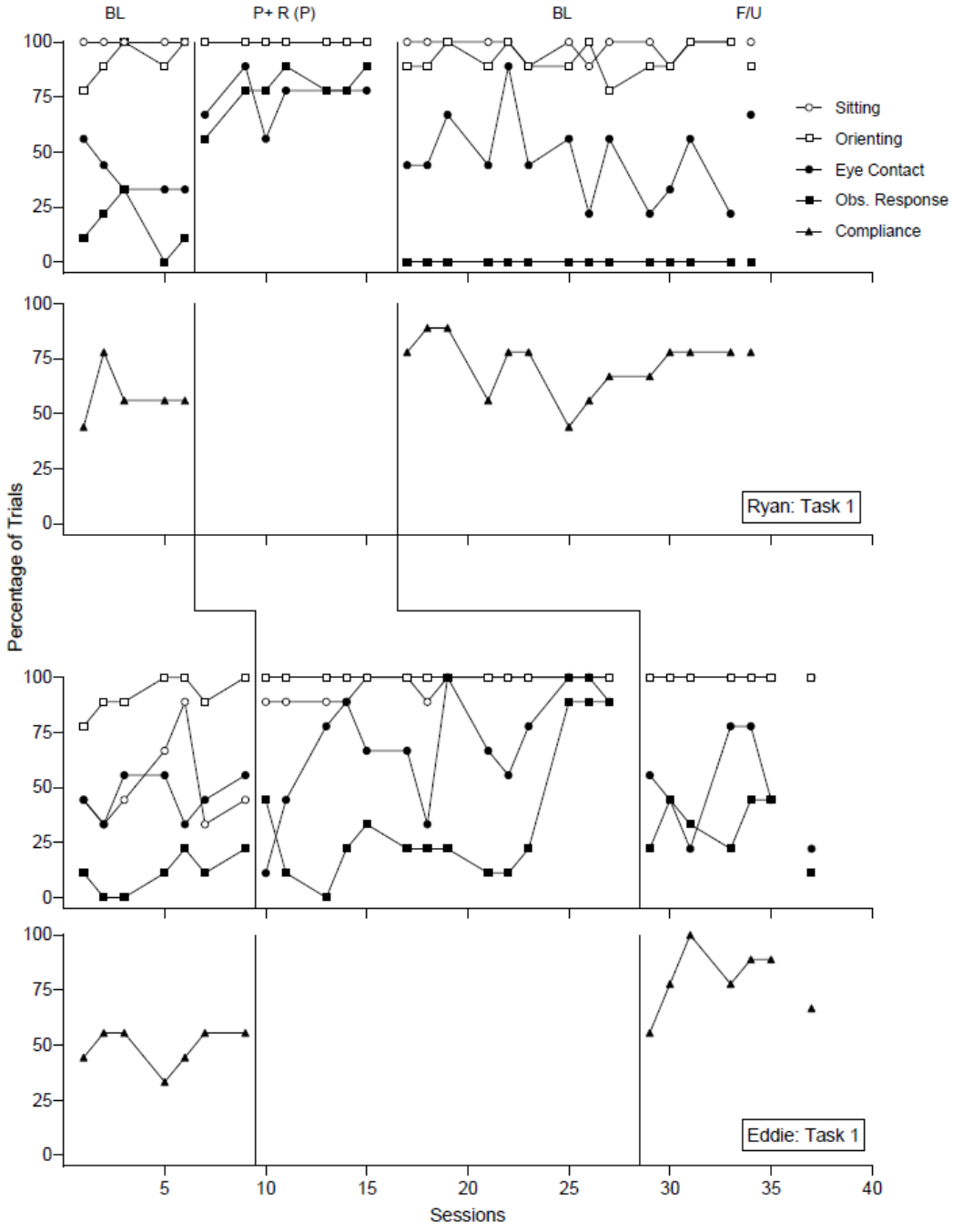
Percentage of Trials in Which Archie Emitted Precursors and Compliance for Task 1 and Task 2



Note. BL = baseline, P+SR (P) = prompting and reinforcement (precursors), P+SR (P+C) = prompting and reinforcement (precursors and compliance), * denotes changes in reinforcement contingency

Figure 4

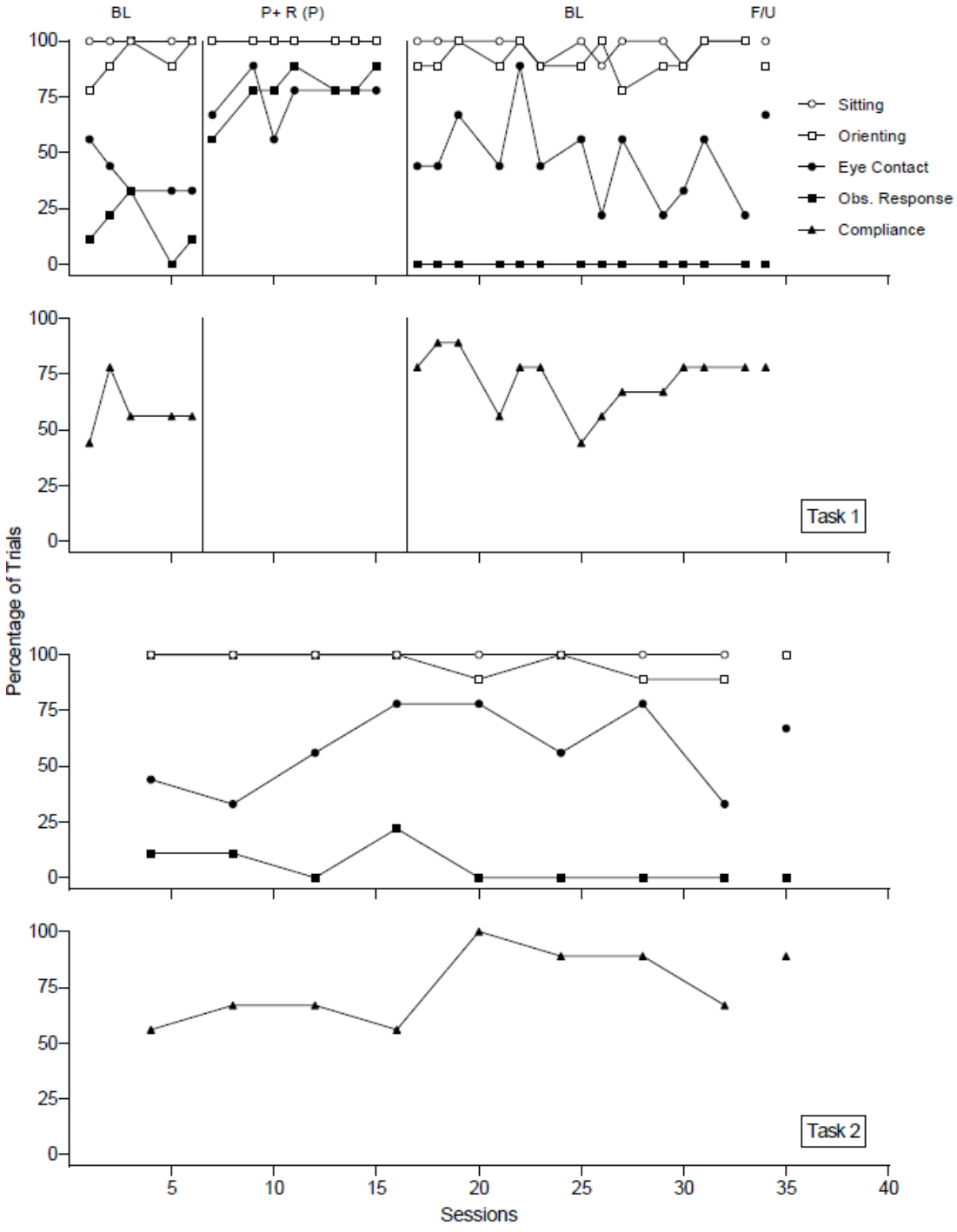
Percentage of Trials in Which Ryan and Eddie Emitted Precursors and Compliance for Task 1



Note. BL = baseline, P+SR (P) = prompting and reinforcement (precursors), P+SR (P+C) = prompting and reinforcement (precursors and compliance), F/U = follow-up

Figure 5

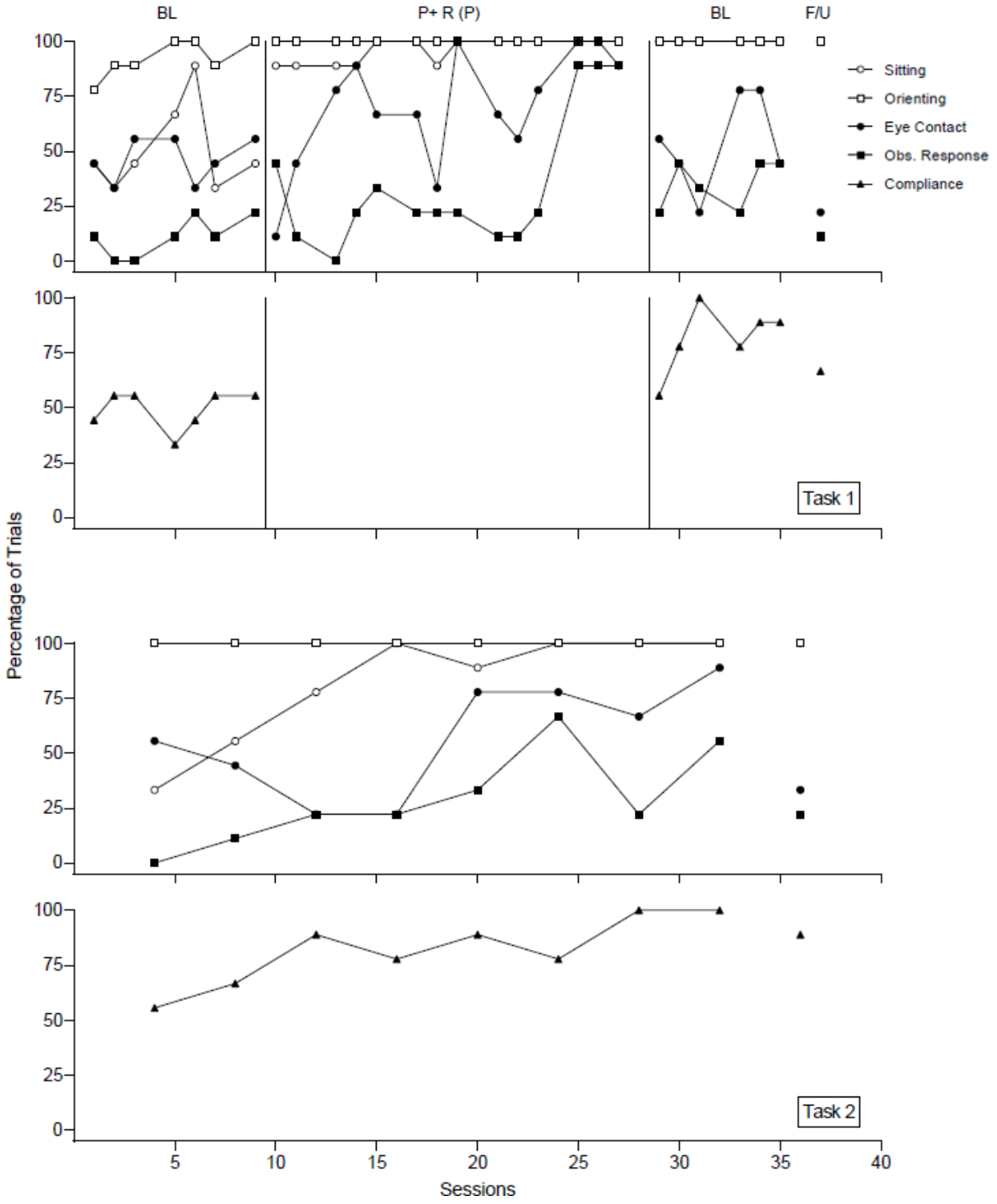
Percentage of Trials in Which Ryan Emitted Precursors and Compliance for Task 1 and Task 2



Note. BL = baseline, P+SR (P) = prompting and reinforcement (precursors), F/U = follow-up

Figure 6

Percentage of Trials in Which Eddie Emitted Precursors and Compliance for Task 1 and Task 2



Note. BL = baseline, P+SR (P) = prompting and reinforcement (precursors), F/U = follow-up