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Non-simultaneous stimulus presentations and their role in listener naming

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Abstract

Previous studies on naming have presented the object and its name simultaneously during both training and testing, and thus the training component may establish a transformation of function *directly* between the object and the name. Successful tests for listener naming may thus *not* require the emergence of a novel (entailed) transformation of function. The current study aimed to control for this possibility by presenting the object and the name sequentially and non-simultaneously. Eight typically developing toddlers participated in the current study. During name training, objects and names were presented non-simultaneously, and all participants failed to emit listener-naming responses during the first test session. Subsequently, four participants received multiple exemplar training, which led to improvements in listener naming for all four; and speaker naming for only one participant. As a control condition, the remaining four participants were tested repeatedly, without multiple exemplar training, and did not show any consistent improvements in their listener or speaker performances. Multiple exemplar training thus appeared to be effective in establishing generalized listener responses, which involved generating entailed transformation of functions. The strategy of using non-simultaneous stimulus presentations could allow for greater precision in identifying the behavioral processes involved in listener-naming.

Keywords: naming, mutual entailment, transformation of function, listener responding, toddlers

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In the natural environment, children often seem to learn the names of objects through *incidental exposure*, that is, simply by hearing a caregiver say its name while jointly attending to the stimulus; such events have been described as naming experiences (Greer & Longano, 2010). For example, while at the store, a caregiver points to a strawberry and says to the child, “Look, there is a strawberry,” and the child then looks at the strawberry while hearing the caregiver say the name. At a later occasion, someone might say, “Do you see the strawberry?” and the child may then point to the strawberry. This is termed unidirectional naming (UiN; Greer et al., 2011), or the listener half of naming. The child might also see a strawberry and say, “There is a strawberry.” This is the speaker half of naming, and the co-occurrence of the two types of naming is termed bidirectional naming (BiN; Greer & Keohane, 2005).

Relational frame theory (Hayes et al., 2001) distinguishes between UiN and BiN, by focusing on the derived transformation of functions that each type of naming requires. According to RFT, derived relational responding always involves a change or modification in the functions of a stimulus in accordance with an entailed relation. For UiN, when a caregiver names a novel object, a young child may subsequently orient towards the object (or point towards it/pick it up), when the name is uttered again. In this case, a relatively limited transformation of functions is involved, assuming that orienting towards an object, pointing at it, or even picking it up are all functionally quite similar. For BiN to emerge, the child not only orients towards the object (or points or picks it up), but also utters or vocalizes the sound that was heard (i.e., when the object was named by the caregiver). This involves a more complex derived transformation of functions because the object is not only controlling orienting but relatively complex vocalizing responses.

The establishment of the listener and speaker halves of naming has been studied extensively in children with autism and developmental disorders (e.g., Greer et al., 2005; Greer et al., 2011; Miguel & Kobari-Wright, 2013). These studies have identified multiple exemplar training (MET) as being a necessary and sufficient method to establish naming (Greer & Ross, 2008). MET is a teaching method that involves teaching a specific behavior in a range of stimulus variations that ultimately results in the emergence of untrained response topographies (Rosales et al., 2011). According to RFT, derived relational responding is established by a history of reinforcement across exemplars, and MET specifically refers to the instructional history that establishes a class of arbitrarily applicable relational responding¹ (Hayes et al., 2001).

However, there have been fewer studies that evaluated these behaviors in typically developing toddlers. Insofar as specific behavior-analytic theories, such as RFT, and other recent theories of human verbal behavior (e.g., Verbal Behavior Development Theory, VBDT; Greer & Keohane, 2005) have argued that naming experiences are critical in the natural language environment of typically-developing children, it seems important to conduct research with this population. One example of such research was reported by Gilic and Greer (2011), who tested the emergence of listener and speaker naming in eight typically developing two-year old children as a function of MET. Prior to the MET, they provided pre-experimental naming exposure using a match-to-sample procedure in which identity matching trials were carried out. That is, the researcher presented an object with the instruction “Match [object name]” while two comparison stimuli (one correct, and one incorrect) were presented before the child. The task was used as a

¹ The reader should note that MET is used in a variety of different perspectives across research domains. In the context of the current manuscript, we adopted the Hayes et al. (2001) definition in which MET involves varying stimulus conditions until generalized arbitrarily applicable relational responding emerges across novel stimuli.

means to ensure that the child was looking at the object while hearing its name. After a predetermined number of correct matching trials, they were tested for listener and speaker responses. None of the participants acquired these responses with the match-to-sample naming exposures. Subsequently, MET with prompting and reinforcement across speaker and listener responses resulted in seven out of eight participants acquiring naming at 83% - 100% accuracy. These findings are similar to Speckman-Collins et al. (2007) who successfully used MET with an auditory matching procedure to establish listener naming in two preschool students.

Two potential limitations to the Gilic and Greer (2011) study are that the authors did not test with novel stimuli post-training, and furthermore the object and its name were always presented together during training and testing. The lack of post-training data with novel stimuli prevents us from concluding that a derived transformation of functions was involved because the naming repertoire was not shown to *generalize* to novel exemplars (see Barnes-Holmes & Barnes-Holmes, 2002). On balance, Luciano et al. (2007) tested *generalized* listener behavior in a toddler and evaluated the impact of MET on listener responding. During training, the instructor used a stimulus pairing procedure to present the naming experience. She first presented the instruction “Look” and ensured that the child was looking at the object, and then presented its name. After multiple such exposures, prompting, and reinforcement during listener training, the child was tested with novel objects. The training resulted in successful listener responding with novel objects. Similarly, Lipkens et al. (1993) repeatedly tested the emergence of derived relations in a 16-month old infant over an eight-month period. In their experiment, they noted that seeing a picture while hearing the experimenter say its name controlled selecting the picture when the name was spoken by the experimenter. Their results also showed that producing the spoken names of the stimuli during training was not necessary for the derivation of entailed

name-picture relations (i.e., the listener half of naming). Critically, however, both Luciano et al. (2007) and Lipkens et al. (1993) presented the object and its name *together* during testing and training.

When the name and the object are presented simultaneously in time and space it could be argued that no derived or emergent transformation of functions is required during a test for listener naming. In other words, when an object is presented to a child and the name of the object is uttered (by a speaker) in the presence of the object, a bi-directional relation between the object and name may be established *directly*; from the child's perspective, they see-object/hear-name *and* hear-name/see-object. If the child is subsequently asked, during a listener test trial, to point to the named object there is no need, therefore, to invoke a derived or emergent transformation of functions to explain a correct response. One way in which to control for this possibility is to employ a procedure that avoids presenting the object and its name simultaneously. For example, the object could be presented to the child and hidden from view *before* its name is uttered by the speaker (i.e., an *object-name* relation is directly trained); if, during a subsequent listener test trial, the child is asked to point to the object upon hearing its name, a derived or emergent *name-object* relation (i.e., transformation of functions) would be involved in making a correct response. The current study adopted this approach.

At this point, it seems important to recognize that researchers have used multiple methods to simulate naming experiences. For example, researchers have used match-to-sample tasks such as the one described above in the Gilic and Greer (2011) study, and the stimulus pairing procedure described in the Luciano et al. (2007) study. Petursdottir et al. (2020) evaluated procedural variations of the stimulus pairing procedure in which the name was either presented before the image or after the image, and with or without a temporal overlap between

the word and the image. They found that speaker responses were unaffected by the order of stimulus presentation, and the best outcomes were reported when there was an overlap between the word and the image. This latter finding suggests that the simultaneous presentation of word and object during name training could indeed be an important variable to explore in research in this area.

Interestingly, basic experimental research, using computerized procedures with adult participants, has explored the impact of different procedures on the emergence of novel matching responses in the context of stimulus equivalence studies (see Sidman, 1994). For example, Zhelezoglo et al. (2020) and Lantaya et al. (2018) presented an auditory sample three times at the start of the trial. Once this was done, the participant was required to touch a green rectangle on the screen after which the visual comparison stimulus was displayed. That is, the sample and comparison were never presented together during training or testing. All participants demonstrated emergent matching responses during test trials (i.e., clicked on the correct auditory comparison when the visual sample was presented). In studying the emergence of naming (listener and/or speaking) there appears to be little research on the impact of inserting delays between the object and the name, and/or ensuring that the object and the name are not presented simultaneously.

As noted above, presenting stimuli simultaneously could generate a transformation of functions *directly* and thus there is no need to appeal to derived or entailed relational responding (Barnes-Holmes et al., 2004; Valdivia-Salas et al., 2013). If participants fail to show the predicted naming responses (UiN and/or BiN) when the name and object are *not* presented simultaneously, theoretical claims that the naming involved a derived or entailed transformation of functions could be questioned when naming occurs using simultaneous training. Furthermore,

if failures are observed when names and objects are not presented simultaneously, then it would be important to “remediate” this deficit using MET to provide some support for the theoretical claims made by RFT for this type of training in establishing emergent (naming) behaviors.

Overall, therefore, research that focuses on the impact of introducing non-simultaneous presentation of the object and its name, and the impact of MET if the emergent naming fails to occur, appears to be important. The current research constitutes the beginning of such a research program.

The current study employed participants who were generally younger than those typically employed in the behavioral literature in studies of derived stimulus relations and naming. Employing relatively young participants may be particularly important when attempting to assess the role of subtle variables on derived or emergent naming behaviors because such variables may have a minimal impact on older individuals. For example, one would not expect a brief delay between the presentation of a novel name and an object to have a dramatic impact on the emergent behavior of older children or adults with more extensive verbal behavior histories. The purpose of the present study was to test the emergence of entailed transformations of functions involved in listener naming following non-simultaneous object-name presentations and MET. Particularly, we made two methodological variations to add to the current literature on this topic: we presented the visual and auditory stimuli non-simultaneously during trials, and we evaluated whether repeated testing (with and without MET) would lead to improved responding during listener and speaker test trials.

Method

Participants

Participants were eight typically developing toddlers (six females and two males) and were all between 17-22 months old (*M*: 18.7 months). All participants lived in Ghent, Belgium and were Flemish. See Table 1 for a list of participants with their language and social communication level measured using the Dutch version of the MacArthur and Bates Communication Development Index (N-CDI; Zink & Lejaegere, 2002) and the Early Social and Communication Scales (ESCS; Mundy et al., 2007).

All participants had some pre-existing listener and speaker responses as reported by their caregivers. For example, the caregivers of P1, P2 and P3 reported that these participants could pick up/point to nouns such as cake, cheese, car, grandpa, cow, hands, and table and could label objects such as car, cheese, and hands. None of these participants spoke in phrases or sentences. Participant P4 could respond to elephant, cow, zebra, cycle, car, hands, bedroom, nose, butter, and rice as a listener. P4 labelled a few animals, body parts, and familiar family members upon request. She emitted short phrases such as “more juice” or “Daddy car” occasionally. Participants P5, P6, P7 and P8 could identify their body parts (e.g., nose, hands), some animals (e.g., dog, cow, elephant), and their preferred foods (e.g., spaghetti, cheese, cake) when they were asked to point to these items. The caregivers reported that they could label nearly 10 items (e.g., car, book, and cake) and could ask for their preferred food or activities. None of these four participants spoke in phrases or sentences.

Setting and Materials

All sessions took place in a research room (10m X 15m) equipped with one table, two adult chairs, one baby chair, and a shelf for placing materials. The experimenter, the participant and one caregiver were present during the sessions. All sessions were videotaped.

Materials used during the experiment included twelve different objects (i.e., A1, A2, A3 etc.) and arbitrary spoken sounds (i.e., B1, B2, B3 etc.) separated into two-member classes. All the stimuli used during training were unfamiliar to the participants (based on caregiver report). See Table 2 for a complete list and description of the stimuli used. We used a random order and combination of stimuli during the testing and training for each participant.

Response Measures and Interobserver Agreement

The main dependent variable used during the testing and training phases was the percent of correct responses. A correct response was defined as touching (or pointing or picking up) the correct comparison during listener trials; and saying the name of the stimulus during the speaker trials. In addition, during the multiple exemplar training phase, the experimenter collected data on the percent of prompted and incorrect responses.

A second independent observer recorded data for all test sessions, and 50% of trials for each set of MET for each participant. For each trial (during a test session or MET), an agreement occurred if both observers scored either correct or incorrect, and a disagreement occurred if one of the observers scored correct while the other scored incorrect. Across all eight participants, agreements during test sessions averaged 99% (range, 94% to 100%), and agreements during MET averaged 98% (range, 91% to 100%).

Procedure

All sessions commenced with the researcher telling the child, “we are going to play with some toys. Mama/Papa is going to stay right here and play with us”. The researcher then proceeded to present some toys to the child (e.g., a ball to roll on the table) and said “come on, let’s play”. The researcher, the child, and the caregiver took a few turns engaging with the toys

(e.g., rolling the ball to each other”). The researcher provided verbal praise by saying “Great job” or “well done” when the child touched/engaged with the toys. Once the child had taken and returned toys to the researcher a few times, the pre-test commenced (described below). During the entire session, the researcher engaged the child in motivating play activities during inter-trial intervals. These activities involved light-and-sound-toys (e.g., a toy sheep that had lights and produced music), wind-up toys that moved or jumped on the table, animals, building blocks, shape sorting puzzles, musical toys (e.g., drum, xylophone), and remote-control toys (e.g., a car that could move and beep on pressing buttons on a remote device).

Pre-test.

To test object–sound relations, the researcher sat facing the child across a table. The researcher held up an opaque bag and said “wow, what is in here?” or “so many more things” to keep the child motivated. She then removed an object from the bag, asked the child to attend to the object (e.g., A1), which she held up in her hand, pointed to, and said, “look at this”. When visual contact occurred, she put the object under a white cloth on the table, then pointed to the region of the white cloth and said “That is BOZO” (B1). No specific consequences were administered, and after the researcher named the object, it was put inside an opaque bag. This trial was called an object-sound exposure trial. This was repeated two more times with the same object with 3- to 5-min inter-trial intervals. During the inter-trial interval, the researcher and the child engaged in unrelated play activities to maintain the child’s motivation. Immediately after the third object-sound exposure, a listener trial was conducted. That is, the researcher presented the object that was previously named (e.g., A1) with two other objects. All three objects were equally *familiar* because all comparison stimuli were presented to the child for a few seconds prior to the first exposure trial to remove novelty effects. The researcher then asked the child to

pick up the object previously named (e.g., “Give me BOZO”). No differential consequences were provided for correct or incorrect responses. This trial was called the immediate listener trial. The listener trial was repeated in the same manner 3 min and 10 min after the immediate listener trial. These trials were called the delayed listener trials. During the 3 min and 10 min delay, the researcher and the child engaged in unrelated play activities to maintain the child’s motivation. In addition to the delayed listener trials, five min after the immediate listener trial, the researcher held up the object (A1) and asked, “What is this?” (or another equivalent version such as “Tell me what this is”). This was called the speaker trial. See Table 3 for a visual representation of all the trials conducted during the pre- and post-test, and Figure 1 for the trial types and trial timings.

Participants who failed the pre-test (i.e., scored incorrect on all trials - immediate listener, both delayed listener trials, and the speaker trial) either received repeated testing with a new object each time (i.e., with object-sound exposures, immediate and delayed listener trials and one speaker trial), or the Multiple Exemplar Training procedure described below.

Repeated Testing

Participants who were repeatedly tested, received two additional administrations of the pre-test. The test was conducted exactly as described above, with the exception that six object-sound exposures (instead of three) were provided for each object. That is, during each object-sound exposure, the researcher pointed to the object, ensured that the child was looking at the object, and hid it under a white cloth. She then named the object and put it away; unlike the pre-test, however, the object was introduced again *immediately* and the procedure was repeated one more time. This “double exposure” trial was repeated after 3- and 5-mins. The listener and speaker trials were conducted exactly as described in the pre-test. A novel object and name were

used during each test administration. After two such test administrations, a post-test was conducted (see below).

Multiple exemplar training for derived transformation of function

During this phase, the session was set up exactly as described above for the pre-test (except novel objects and sounds were employed for each exemplar). The trial first involved the presentation of the object-sound exposure exactly as described in the pre-test. The trial was repeated two more times at 3- and 5-min intervals as described in the pre-test. In contrast to the immediate listener test, the child was asked to “give me [object name]” (e.g., “give me PAF”), and then the instructor presented the previously “named” object on its own. When a correct response occurred, the instructor provided verbal praise (e.g., “All right, very good”). If the child looked away or did not respond, the instructor physically guided the child to pick up the object. Shortly thereafter (depending on the child’s willingness to continue), this trial with just one object to choose from was repeated one more time.

Having completed the two one-choice trials, the researcher then presented a series of three-choice trials until the child responded correctly two consecutive times. Specifically, on these trials, the participant was presented with three objects (e.g., B3, B4 and B5) with the instruction “Give me [previously named object]” (e.g., “PAF”). The researcher was careful to focus their gaze on the child’s mouth to avoid visual prompting. When a correct response occurred, the instructor provided verbal praise (e.g., “Great job”, “you are a champion”). If the response was incorrect, the instructor said, “No, that’s not it,” and put the incorrect comparison away, and initiated a correction trial immediately. This involved the instructor saying “Give me [previously named item]” (e.g., “PAF”), and presenting only the correct comparison before the child. The child was required to pick up the object and give it to the researcher (with or without

physical prompts) during the correction trial. Having completed the correction trial, the researcher resumed three-choice trials. That is, the trials continued until the child completed two consecutive correct responses during three-choice trials. These three-choice trials were all conducted at various delay durations relative to the last object-sound exposure trial (conducted at the beginning of the training session), and these durations varied randomly across participants based on their motivation level.

Subsequently, a second A to B relation (e.g., A4 to B4) was taught. Training for the second A to B relation was carried out in exactly the same manner, beginning with three object-sound exposures, followed by two one-choice trials, and a series of three-choice trials. The three-choice trials for the second relation were interspersed with trials for the first relation (i.e., A4-B4 trials were interspersed with A3-B3 trials). See Table 4 for a visual representation of the training procedure, and Figure 2 for the trial timings and trial types.

When two consecutive correct responses occurred for both pairs of stimuli during the interspersed trials (i.e., each of A4-B4 and A3-B3), training was terminated for this set and the same procedure was carried out for two more pairs of stimuli (e.g., A5-B5 and A6-B6). Training for the second set was carried out in exactly the same manner as the first set. Once both sets were complete, a post-test was administered.

Post-test

All eight participants underwent a post-test (with the three object-sound exposures, three listener trials and a speaker trial) conducted exactly like the pre-test with a novel set of stimuli. We provided no prompts or differential feedback during the post-test.

Results

The results of all eight participants are displayed in Figures 3, 4, and 5. Figure 3 shows the results of participants P2, P4, P6, and P7 who were repeatedly tested but did not receive MET. None of these participants exhibited correct responses to listener or speaker trials during the pre-test. All these participants were administered the pre-test two more times during the repeated testing phase. P2 and P4 each responded correctly to one immediate listener trial during the second administration of the pre-test. In addition, P4 responded correctly to two immediate listener trials during the third administration of the pre-test, but did not show any improvements during the delayed listener trials. The phase change lines in Figure 3 serve to indicate that during the second and third administrations of the pre-test, the double exposure trials (see Method) were conducted prior to the listener and speaker trials. During the post-test, P6 responded correctly to one immediate listener trial and P7 responded correctly during one of the delayed listener trials. P2 and P4 did not emit any correct responses. Overall, none of the participants that were tested repeatedly showed consistent improvements in their listener or speaker performances across test sessions.

On the other hand, participants who received MET showed clear improvements in listener responses over the course of the study. Four participants (P1, P3, P5, and P8) received MET. The top panels on Figure 4 and 5 depict the responses emitted during the pre- and post-tests conducted before and after MET respectively. None of the participants emitted correct listener or speaker responses before MET, and all four participants provided correct listener responses (both immediate and delayed) after MET. However, only P3 responded correctly to the speaker trial during the post-test.

The bottom panels on Figures 4 and 5 depict the participants' responses during MET. All four participants (P1, P3, P5, and P8) successfully completed MET and met mastery criteria

across both training sets in 22, 28, 25, and 22 trials, respectively. On average, they took 13 trials (range: 10 – 16) to complete set 1, and 12 trials (range: 10 – 13) to complete set 2. Participant P3 made two errors, and P5 made one error during MET. On average, participants made more omissions (i.e., did not provide a response) than errors. P3 made two omissions while P1, P5 and P8 made one omission each during MET. See Table 5 for specific mastery information, errors and omissions for each participant. Overall, multiple exemplar training seemed effective and sufficient in producing generalized listener, but not speaker, responses in our participants.

The testing and training took 2 sessions for all eight participants, and on average, each session lasted 51 min (range, 42 to 69 min). The average session duration for participants who received MET and those who were tested repeatedly were 53 min (range, 47 to 69 min), and 48 min (range, 42 to 58 min) respectively.

Discussion

The current study aimed to investigate the impact of non-simultaneous presentation of an object and its name on listener naming responses, and to evaluate the effectiveness of multiple exemplar training to address deficits identified with such a presentation. Overall, generalized listener responses emerged in all participants, and speaker responses in one participant, following MET. Repeated testing (without MET) showed some instances of correct immediate listener responses but did not result in consistent improvements across listener or speaker trials for any of the participants.

The reader should note that participants who were tested repeatedly emitted few correct listener responses in spite of a 33% probability of a correct response on each trial (i.e., because there were only three objects to choose from). Specifically, many of the incorrect responses

involved the child not picking up any object, and as such it appears that they did not engage in simply “guessing” what the correct response could be (see Table 5). Interestingly, a similar pattern was also observed by Gilic and Greer (2011) in their study with 2-year old children. The authors speculated that the children did not engage in “guessing” because they had no prior history with instructional presentations in which guessing was reinforced. Given that all of our participants were under two years of age, this also seems a likely explanation for our participants.

A potentially important feature of the current results for the participants who received MET is that a relatively limited number of exemplars (four exemplars) appeared to be sufficient before demonstrating the targeted derived listener performances. It is possible, therefore, that the exemplar training simply “activated” an already existing or nascent repertoire of entailed transformation of functions, rather than establishing such a repertoire, *ab initio*. Indeed, perhaps it could be argued that the exemplar training simply motivated and/or prompted the child to emit the correct (mutually entailed) responses during test trials. On balance, if the role of MET was solely motivational/prompting, conducting one-choice trials alone would have allowed the child to contact favorable consequences (i.e., praise) for responding. However, the improvement in listener responses was gradual across exemplars, and errors seemed to occur more frequently in the initial phases of MET than later. Thus, it seems highly unlikely that the MET provided a simple motivational prompt for participants to choose the correct object.

A particularly important finding in the current study is that although the emergence of listener responses was consistently observed for all participants who underwent MET, only P3 demonstrated speaker-naming (showed bi-directional naming) upon request during the post-test. Thus, generalized listener responding emerged in the apparent absence of speaker responses in

three of our participants. These results are consistent with the findings of Luciano et al. (2007) and other earlier studies (e.g., Horne et al., 2004; Lipkens et al., 1993; Lowe et al., 2002). Upon reviewing the videotaped sessions from the current study, the researcher noted that P3 was the only participant who spontaneously engaged in echoic responding (and she was the only participant who showed correct speaker responding). Specifically, she immediately repeated the object names spoken by the experimenter during name-object exposure trials in the post-test even though the procedures did not require her to do so. This outcome is consistent with the empirical findings of Lipkens et al. (1993) and Lowe et al. (2005) and fits the theoretical account of Horne and Lowe (1996) who suggested that echoing was a prerequisite for speaker-naming responses. Of course, the finding is *post-hoc* in the current study, and is based on the behavior of only one participant, but seems worthy of further research in future studies that also employ the non-simultaneous presentation method we have developed here.

There are some methodological limitations to the current study. First, it may have been better to employ a multiple-baseline design across participants to test the effectiveness of our procedures. The decision to employ the current design was based in part on the practical and time constraints presented by the COVID-related research guidelines and the expected motivation level of the particularly young children who participated in the current study (i.e., alternative designs may have required numerous sessions, rather than just two). Second, we relied on caregiver reports in defining stimuli as “unfamiliar” for the children. Future research might employ relatively abstract shapes that would be equally unfamiliar for each child. On balance, we used a novel object and name for each test administration and each set of multiple exemplar training, making it less likely that the results were affected by familiarity. Third, we assessed speaker responses only once during each administration of the test (i.e., the pre- and

post-tests) while listener responses were assessed three times; perhaps additional speaker trials could have produced stronger evidence for the emergence of bi-directional naming.

Parenthetically, it should be noted that the (one only) speaker test trials were added with no particular expectation that correct speaker responses would emerge. As noted previously, based on previous empirical and conceptual analyses there was no basis on which to predict the emergence of correct speaker responses given correct listener behavior, but it seemed wise simply to check what might emerge in terms of informing future research (e.g., would explicit testing and/or training echoic responses in a future study produce successful speaker responding?)

The current study employed a method that involved presenting an object and its name non-simultaneously during name training, and all of our participants initially failed to demonstrate listener naming responses. This finding raises potentially important theoretical issues for the relationship between naming (both uni- and bi-directional types) in general and the concept of entailed transformation of function as a behavioral process. As argued in the introduction, when stimuli are presented simultaneously during name training trials it is possible that when listener naming occurs during test trials it could involve a *directly trained* transformation of functions, rather than an emergent or derived performance. However, when an object and its name are presented non-simultaneously during training, and then naming is observed during test trials (either listener or speaker versions) then at the very least the transformation of functions involves an entailed relational response, as defined within RFT. Critically, approaching the research in this manner encourages us to be precise in defining the behavioral processes that may be involved when children learn to name objects in both experimental and natural contexts. As an aside, it is worth noting that in the current study objects

and names were presented non-simultaneously during the training trials (i.e., all object-sound exposure trials), but during the test trials they were presented simultaneously (i.e., the name was presented in the presence of three objects). Perhaps future research could explore the impact of using a non-simultaneous format during both name training *and* testing, and explore the potential impact of MET on such test performances.

The data presented here also have applied relevance. Children with developmental disorders such as autism often present with deficiencies in the naming repertoire. Primarily, the current data lend support to the utility of MET when the predicted naming responses fail to emerge spontaneously with a non-simultaneous presentation of stimuli. Although the current non-simultaneous method of presenting names and objects is yet to be tested with a sample of children with disabilities, the study offers a potential method for practitioners to train and establish derived listener responses of increasing complexity should they fail to emerge in such children. Further, the methods described here adopt a naturalistic format for practitioners to provide naming experiences with brief inter-trial intervals that involve other activities and without mass name-object exposure trials that are typical of laboratory experiments (e.g., Byrne et al., 2020; Petursdottir et al., 2020). Finally, if future studies employing the non-simultaneous presentation technique confirm the emergence of echoic responding during training and/or testing (even when procedures do not explicitly require doing so), this could have potential implications for interventions for children.

The present study marks the first step in a research program to evaluate the impact of non-simultaneous stimulus presentations during naming experiences and investigating methods to remediate any deficits that may be observed. We noted that predicted listener naming responses failed to emerge when delays were introduced between the presentation of objects and

their names. When the naming responses failed to emerge, multiple exemplar training appeared to be effective and sufficient in establishing generalized listener responses in all of our participants and speaker responses in one participant. The current evidence clearly indicates that this is an area of study that warrants further research for a better understanding of the behavioral processes that may be involved in naming with clear implications for potential intervention.

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Table 1*Participant Information.*

	Gender	Age (months)	RJA score (%)	IJA score (rate/min)	N-CDI		Training received
					Word Comprehe nsion Age	Word production Age	
P1	Female	17	62.5	0.75	20	16	MET
P2	Female	19	75	0.6	19	20	Repeated testing
P3	Male	19	87.5	0.7	22	18	MET
P4	Female	22	87.5	0.9	24	23	Repeated testing
P5	Female	17.5	75	0.6	18	16	MET
P6	Male	18	62.5	0.7	18	16	Repeated testing
P7	Female	20	75	1.1	20	19	Repeated testing
P8	Female	17	75	0.7	20	18	MET

Notes. RJA = Receptive joint attention measured using the Early Social and Communication Scales (ESCS: Mundy et al., 2007); IJA = Initiating joint attention measured using the Early Social and Communication Scales (ESCS: Mundy et al., 2007); N-CDI = Dutch version of the Communication Development Index; MET = Multiple Exemplar Training

Table 2*Stimuli used during training.*



















Object (A)	Name (B)	Description
A1	BOZO	
A2	YAMO	
A3	VEK	
A4	PAF	
A5	MESA	
A6	WONI	
A7	TIC	
A8	MOT	
A9	AUKA	
A10	KOER	
A11	IBE	
A12	DUNA	

Table 3

Description of trials conducted during the pre- and post-test

Antecedent	Behavior	Consequence
<i>Object-sound exposure trial</i>		
“Look at this” (pointing at object) 	Child looks	Researcher hides object under a cloth  → 
“That is BOZO” (pointing at hidden object) 	N/A	No differential consequences
(Two more identical object sound exposure trials conducted at 3-min to 5-min inter-trial intervals)		
<i>Immediate listener trial – 0 sec after third object-sound exposure trial</i>		
“Give me BOZO” 	Correct: Child picks up and gives BOZO Incorrect: No response, and any other response	No differential consequences
<i>Delayed listener trial – 3 min and 10 min after immediate listener trial</i>		
“Give me BOZO” 	Correct: Child picks up and gives BOZO	No differential consequences

Incorrect: No response, and
any other response

Speaker trial – conducted 5 min after immediate listener trial

“What is this?” while
holding up BOZO





Correct: Child says “BOZO”

Incorrect: All other
responses including no
response

No differential
consequences

Table 4

Description of trials conducted during one set of Multiple Exemplar Training

Antecedent	Behavior	Consequence
<u>Object-sound exposure trial</u>		
“Look at this” (pointing at object)	Child looks	Researcher hides object under a cloth
“That is PAF” (pointing at hidden object)	N/A	No differential consequences
(Two more identical object sound exposure trials conducted at 3-min to 5-min inter-trial intervals)		
<u>One-choice trial</u> –two trials conducted immediately after second and third object-sound exposure		
“Give me PAF” (object presented after instruction)	Correct: Child picks up and gives PAF Incorrect: No response, and any other response	Prompts provided if no response occurs; verbal praise for correct response
		
<u>Multiple choice trials</u> – conducted at varying durations after the third object-sound exposure		
“Give me PAF” 	Correct: Child picks up and gives PAF	Verbal praise for correct response; one-choice trial

Incorrect: No response, and conducted for incorrect
any other response response

(Same sequence was repeated for the second exemplar of the set once mastery criterion
was met for the first exemplar)

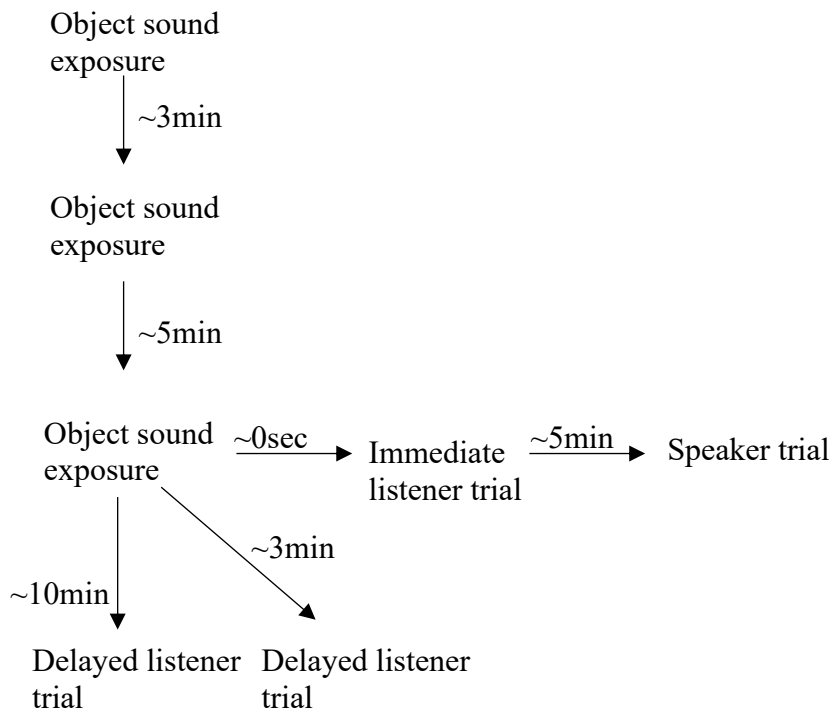
Table 5

Trials to mastery and errors during MET

	Set 1 (MET)			Set 2 (MET)		
	Trials to mastery	Errors	Omission	Trials to mastery	Errors	Omission
P1	12	0	1	10	0	0
P3	16	1	2	12	1	0
P5	10	0	0	15	1	1
P8	12	0	1	10	0	0

Figure 1

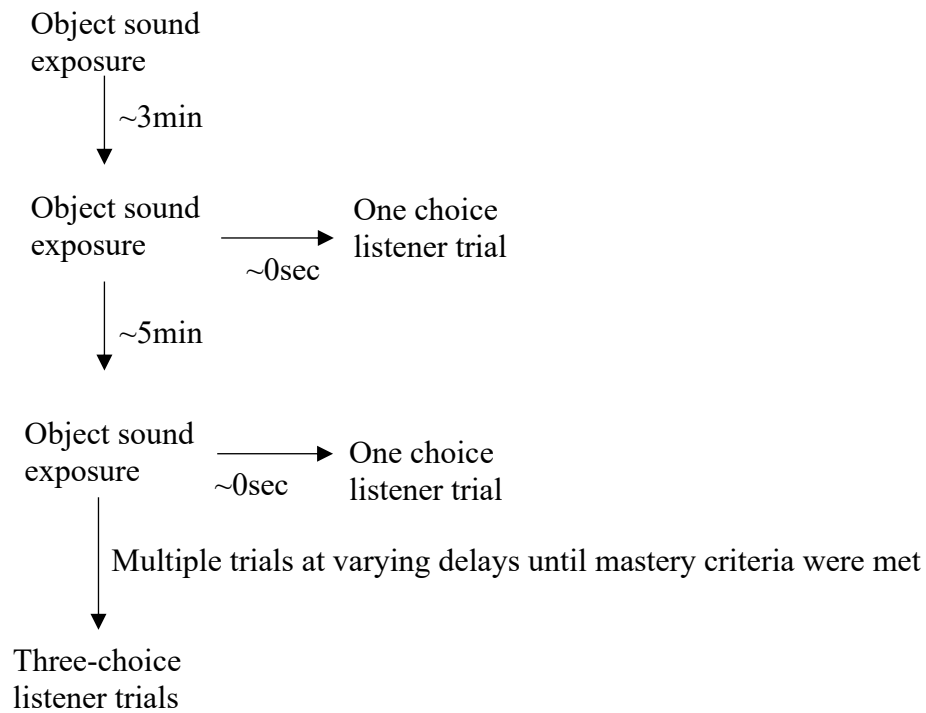
Trial timings and trial types during the pre-test and post-test



Note. Numbers indicate delay between the trials.

Figure 2

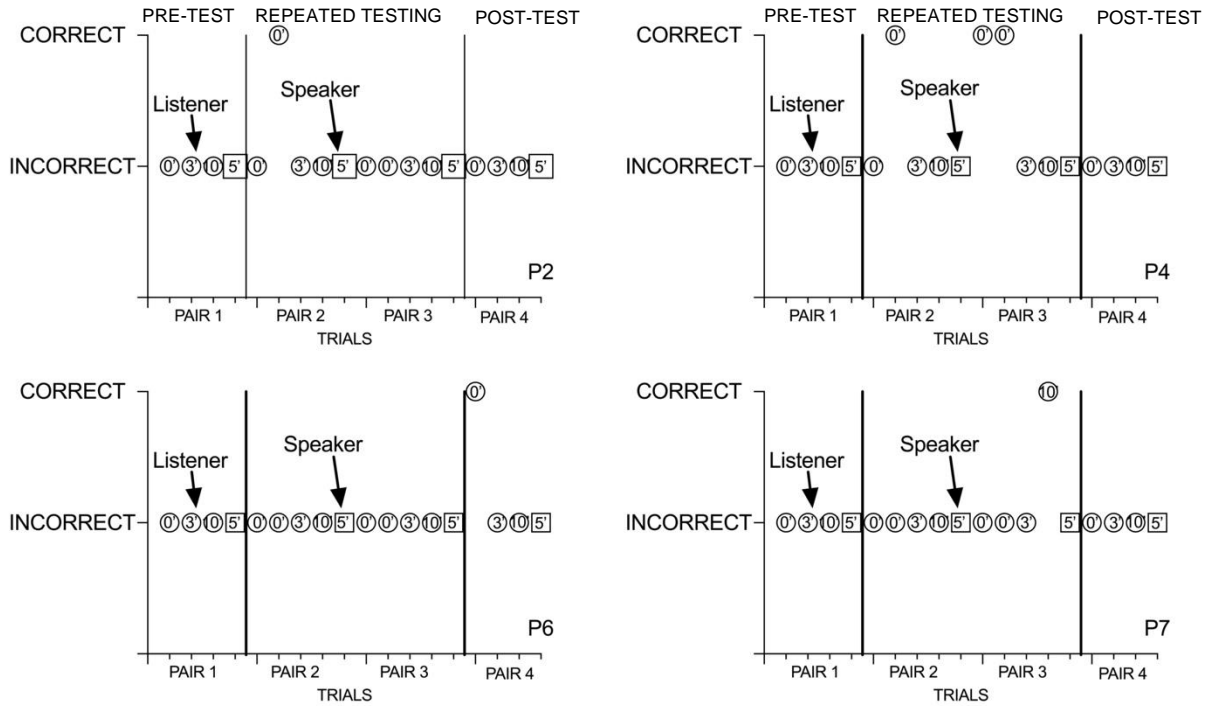
Trial timings and trial types during MET



Note. Numbers indicate delay between the trials.

Figure 3

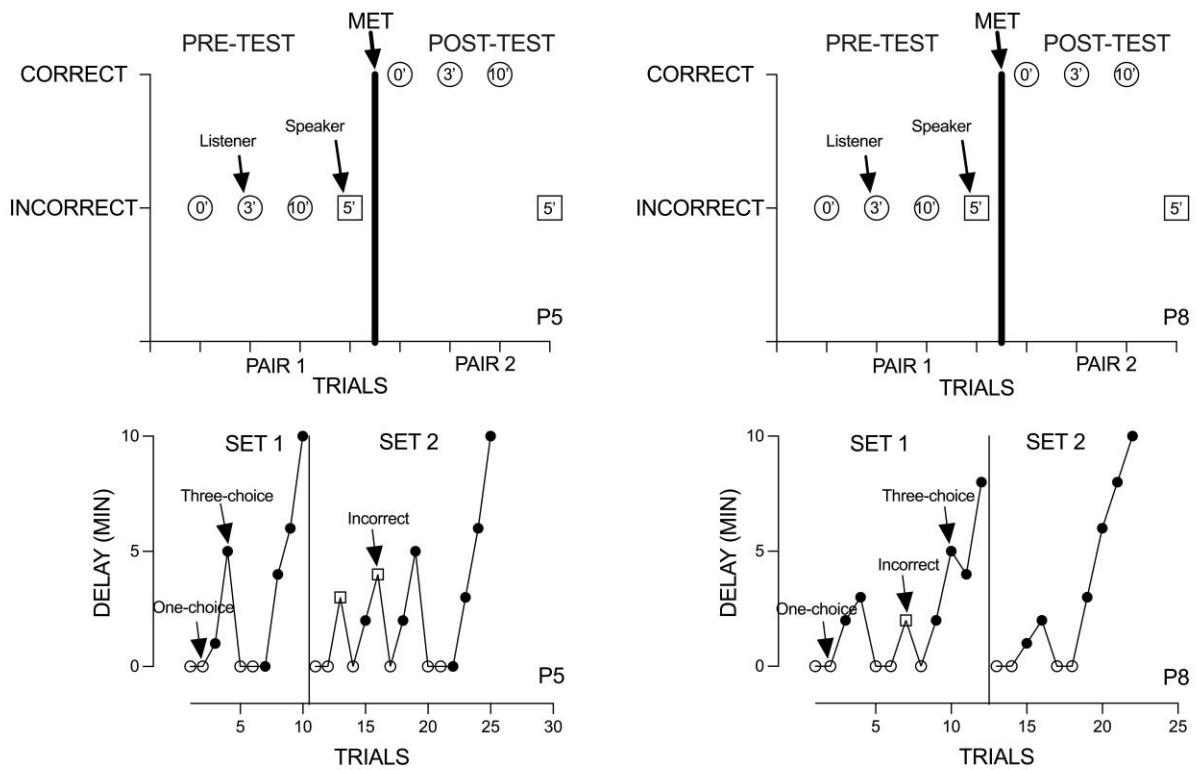
Effects of repeated testing on the listener and speaker responses of P2, P4, P6, and P7.



Note. Numbers indicate delay (in min) between last object-sound exposure and the trial.

Figure 5

Responses of P5 and P8 during the pre-test, post-test and multiple exemplar training.



Note. Top panels depict listener and speaker responses during Test 1, and bottom panels depict listener responses measured across delay durations during multiple exemplar training (MET). Numbers in the top panel indicate delay (in min) between last object-sound exposure and the trial.