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Generalized Use of Past Tense Verbs in Children with Autism Following a Sufficient Exemplar Training Procedure

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Abstract

The purpose of this study was to validate a procedure for sufficient exemplar training that can potentially lead to generalized responding. Based on this procedure, we taught four children with autism, generalized use of regular past tense verbs. We applied a non-concurrent multiple baseline design across the participants. The dependent variable was the number of verbs that needed to be trained for generalization to untrained verbs to occur. The number of verbs that needed to be trained varied considerably across participants as did the number of trials. We concluded that the procedure was validated and that it was easy to implement and it allows for individualization. We discuss the practical implications of our findings for teaching a wide range of skills using the same type of training procedure and data display strategies we provided in this study.

Keywords: Sufficient exemplar training, Autism, Generalized responding, Past tense

Introduction

One of the many challenges for persons with autism is lack of generalization of skills across such dimensions as setting, type of material, wording of instructions, and different communication partners. Another challenge is a lack of generalization from explicitly taught exemplars of a response class to untaught members of that class (e.g., labeling untaught exemplars of cars). Furthermore, limited generalization within higher order operant classes may also be a challenge (e.g., imitating untaught exemplars of gross motor movements or matching stimuli that have not been explicitly taught).

We have found two studies that taught the correct use of the past tense verbs in children with autism and/or intellectual disability. In one study, three adolescents with intellectual disability were taught generative use of regular verbs through imitation and

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reinforcement procedures (Schumaker & Sherman, 1970). Both past and present tense verbs were taught until the criterion was reached within four classes. One class was –t (as in stopped); a second class was -d (as in climbed), a third class was –ted (as in painted) and a fourth one was – ded (as in graded). Following training, the researchers observed generative responding within these classes and that some of the children learned individual verbs faster as the experiment progressed. Overgeneralization was also observed in that verbs that had been said correctly previously, in one of the classes, were said incorrectly but in accordance with the more recently trained class.

In another study, a total of seven children with intellectual disabilities and autism were taught one or two sets of five regular past tense verbs through MEI (Greer & Yuan, 2008). Generalization of correct past tense use to novel regular verbs and overgeneralization to irregular verbs was observed in all of the participants. Greer and Yuan did not make any distinction between the verbs based on inflection, and children in their study did not seem to have any problems with responding correctly across inflection classes. Although these studies successfully established the generalized use of the past tense, since the verbs were taught in sets, it allowed for limited individualization. It may also be that more verbs than needed were trained.

Several teaching procedures have been identified that promote generalization. One of the most commonly described in the literature, is the teaching of sufficient exemplars (Cooper, Heron, & Heward, 2007; White et al., 1998). Although the strategy for teaching sufficient exemplars is straightforward – train enough exemplars for generalization to occur in new, untrained exemplars – the specific procedures used to train sufficient exemplars differ across research studies. Currently, there does not seem to be specific step-by-step recommendations for how to do this in practice. Additionally, no recommendations have been provided as to what may be appropriate criteria for mastery for each exemplar, nor have recommendations been provided regarding how and if exemplars should be mixed during teaching.

Training sufficient exemplars is sometimes used interchangeably with training multiple exemplars (sometimes called multiple exemplar instruction; MEI; see Greer & Yuan, 2008). However, some authors point out that there appears to be some differences between the two instructional methods. In MEI, typically, several exemplars are trained concurrently and then, subsequent probes for generalization to untrained exemplars are conducted (White et al., 1998). In sufficient exemplar training however, it seems common to train one exemplar at a time to mastery and then conduct a probe on an untrained exemplar (or sometimes several untrained exemplars). There is some evidence to suggest that concurrent training, like in MEI, leads to more rapid acquisition and more generalization to untrained stimuli, such as across different letter fonts (Wunderlich, Vollmer, Donaldson, & Phillips, 2014). However, concurrent training of many exemplars may sometimes be impractical (depending on the task at hand) and may also lead to teaching more exemplars than is actually needed for generalization to occur, wasting time and resources.

The manner in which typically developing children acquire language appears to be more similar to sufficient exemplar training. Detailed descriptive analysis of language development suggests that language (including the correct use of the verb tense) is taught through a number of three-term contingencies in interaction with parents (Moerk, 1990). Children may learn the past tense form of *one* verb in the kitchen one week, and the past tense form of another verb in the bathroom the next week. Idiosyncratic learning of other verbs continues over the course of months or years and at some point the generalized use of past tense verbs is established. Indeed, it is common for children to overgeneralize and apply the regular past tense form to irregular verbs (as in saying “runned” instead of ran).

This process occurring in the natural environment – although slowly and unsystematic – is reminiscent of sufficient exemplar training. It is therefore conceivable that teaching sufficient exemplars of verbs more systematically may speed up acquisition. It is also conceivable that individuals with special needs, who have not generalized across the past tense form of verbs, may do so if they are taught more systematically.

Some of the most commonly used curriculum manuals for teaching children with autism suggest teaching a set number of items within a class (e.g. teach imitation of 10-15 gross motor movements, then move onto fine motor; teach matching of 15 objects, then move onto pictures (e.g., Lovaas, 2003: Sundberg, 2008, Leaf & McEachin, 2008; Maurice 1996). One problem with this strategy is that you cannot be sure that the child has learned enough exemplars for generalization to novel exemplars to occur.

An alternative to teaching sets of exemplars (as in MEI) is to teach only one exemplar at a time in succession. In the case of teaching the past tense, this will mean teaching one verb at a time and when this one verb is mastered, a probe of untrained verbs is done to see if generalization occurs. There are some possible benefits to this procedure. Specifically, this procedure would allow the therapist to identify exactly when generalization to untaught verbs occurs, and to stop further teaching at that point. This could potentially save time and resources, by reducing the number of exemplars taught (as when you are teaching sets), and allows for a much greater degree of individualization. The next step in teaching would be guided by data for that individual and not simply by the completion of certain sets or a certain numbers of exemplars. Variations of this procedure was successfully used to teach children with autism cooperative play (Jahr, Eldevik & Eikeseth, 2000) and to answer Wh-questions (Jahr, 2001). Both of these studies reported generalization across people and time following mastery in training.

The aim of the present study was to validate a procedure for sufficient exemplar training where one verb is taught at a time, and where generalization probes are conducted after mastery of each verb. An important part of the procedure is applying behavioral criteria for when to teach the next verb and for determining if generalization has occurred. Applying behavioral criteria allows for tailoring. Each participant can be taught exactly the number of verbs that are needed for generalization to occur. The pace for introducing new verbs is also individualized in that each new verb needs to be mastered before the next one is introduced. In order to check other types of generalization we included tests for generalization across people and time.

Method

Participants and Setting

Three boys and one girl with diagnosed with autism participated in this study. Their age was between 6 and 20 years. The level of functioning was significantly below the average as measured by standardized assessments of intelligence and adaptive behavior. Their everyday language mainly consisted of 2-5 word phrases. They labeled verbs in daily life and from pictures using the present tense in the simple (e.g., walk) or continuous form (e.g., walking). They did not use the past tense when they talked about what they had just done or what they did yesterday as reported by their parents and staff in semi-structured interviews (i.e., the expressive subdomain on Vineland Adaptive Behavior Scales-II (Sparrow, Cicchetti, & Balla, 2005) or when probed informally. All of the participants received intensive behavioral intervention, either at school or in their home. See table 1 for a more detailed description of the participants.

Table 1. *Age of participants at intake. Intellectual functioning and adaptive behavior levels are given as standard scores. Weekly hours, and years in EIBI programs along with their usage of past tense verb prior to the study, are also provided.*

Characteristics	Chris	Roy	Charlie	Gretchen
Age	10	6	20	11
Full scale IQ [a]	44	na	47	na
Adaptive Behavior Composite [b]	62	74	55	61
Communication	65	76	54	na
Daily Living Skills	69	75	58	na
Socialization	57	68	56	na
Weekly hours of EIBI during study	15	20	10	20
Years in EIBI	8	2	17	8
Regular Past Tense Usage	None	None	None	Some

Note. EIBI = Early Intensive Behavioral Intervention; na = not available

[a]Roid, G. H. (2003). Stanford-Binet Intelligence Scales, Fifth Edition, technical manual. Itasca, IL: Riverside Publishing.
[b]Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2005). Vineland Adaptive Behavior Scales: Second Edition. Circle Pines Minnesota: AGS Publishing.

Dependent Variable

We collected trial-by-trial data on the participant's responding during baseline, training, post-test, generalization across people and at follow-up. The dependent variable was the number of past tense verbs that needed to be taught before generalization to untaught verbs occurred. In addition, we counted the number of trials needed to reach the criterion for mastery of each single verb during the intervention, and to reach the criterion for mastery in generalization. The criterion for mastery when teaching a verb separately was three consecutive correct responses in a massed trial format, and then 5 consecutive correct responses in a random mix with other mastered verbs. The criteria for mastery in generalization, was correct responding on five consecutive untaught verbs.

Design

We applied a non-concurrent multiple baseline design across participants to evaluate the effects of training. Participants were assigned to baseline lengths of one day (participant 1; Chris), one week (participant 2 and 3; Roy and Charlie), and four weeks (participant 4; Gretchen). In each baseline session we probed the participants' correct use of regular verbs in the past tense. We did this by going through a list of 20 verbs, probing each verb twice.

The probes were conducted by showing the participant an action (e.g., bouncing a ball), and then after 1-2 seconds, asking, "What did I do?" The correct answer was to use the past tense form of the verb (e.g., "Bounced" or "Bounced the ball" or "You bounced the ball"). One-word answers were accepted as long as the correct verb tense was used and the answer was clearly pronounced. Incorrect pronoun use or other grammatical mistakes

(e.g., if the participant said "I bounced the ball!" instead of "You bounced the ball!") were also accepted provided the participant used the correct past tense form of the verb. If the therapist was in doubt, the response was scored as incorrect. No feedback was given to the participants during this baseline testing. Following the intervention, a probe session – similar to the probe sessions in baseline - was conducted with two other therapists, one therapist that was familiar with the participant but not involved in the study and another therapist that did not normally work with participant. This was done to test for generalization across different persons.

During the intervention phase, each new verb was probed, to see if the participant responded with the correct past tense without training. If the participant responded correctly only after training of a particular verb was introduced, and this was replicated across several verbs and participants, it would suggest that the training was the reason for the participants correct past tense usage. Furthermore, it would suggest that training x number of verbs in this way, eventually can lead to generalization to new untrained verbs. This procedure also allows the ability to pinpoint the precise number of verbs needed to be trained before generalization to untrained verbs occurs.

Regular Verb Selection

The regular verbs were selected from a list of all regular verbs. Actions that could easily be demonstrated in a discrete-trial-teaching format were preferred (e.g., clapping, jumping). In addition, only verbs that the participant could label in the present tense and pronounce clearly were included. If the participant used the past tense correctly for any given verb on a consistent basis (i.e., correct on every probe in baseline), that verb was not included in the study. The list was therefore somewhat individualized. However, 16 of the 20 verbs included, were common for all participants. See Table 2 for a list of the verbs included and how they were presented (the order of introduction varied somewhat across the participants).

Table 2. *List of regular verbs included in the study and how they were presented. The presentation was followed by a 1-2 second pause and the question 'What did I do?'*

#	Verb	How it was presented
1	Clap	Clapping hands 3-4 times
2	Jump	Jumping up and down 3-4 times
3	Knock	Knocking 3-4 times on table with knuckles
4	Wave	Waving 3-4 times with hand
5	Bounce	Bouncing a ball 3-4 times on floor
6	Kick	Kicking the wall
7	Pat	Patting own arm
8	Spray	Spraying the table with soap
9	Smile	Smiling at participant

Table 2 (Cont.). *List of regular verbs included in the study and how they were presented. The presentation was followed by a 1-2 second pause and the question 'What did I do?'*

#	Verb	How it was presented
10	Rip	Ripping a piece of paper
11	Wipe	Wiping own mouth with paper
12	Roll	Rolling the ball 2-3 meters on floor
13	Cry	Pretending to cry
14	Blink	Blinking with both eyes
15	Fold	Folding a piece of paper in two
16	Close	Closing a container
17	Walk	Walking across the room
18	Open	Opening a container

Procedure

Training sessions were embedded into the participants' regular teaching sessions and conducted for approximately one hour per day. The participants' therapists conducted all training and testing. The therapists had between 6 months and 7 years of experience with discrete-trial-teaching and the fidelity of their teaching was monitored regularly. The monitoring included several components of discrete trial teaching such as presenting instructions and teaching materials, prompting, shaping, delivering consequences and providing session structure. Prior to this study, all of the therapists involved demonstrated at least 90% adherence to a proprietary checklist monitoring discrete trial teaching skills.

Sufficient Exemplar Training Strategy

The intervention phases started with probing the first verb on the list in the same way it was probed in baseline. The therapist showed the action and after 1-2 seconds asked, "What did I do?" After a maximum of two consecutive incorrect responses (no response was also scored as incorrect) a verbal modelling prompt was provided and the question repeated ("What did I do? Clapped! What did I do?"). After a prompted trial, another trial was presented with the same verb. Hence, the participant was always given the opportunity to respond correctly without a prompt after a prompted trial. We always prompted one-word answers (e.g., "Clapped" rather than "You clapped"). The criterion for mastery when targeting a verb separately was three consecutive correct responses. When this was achieved, the verb was mixed randomly with 1-3 other mastered verbs from the list (except for the very first verb when no other mastered verbs were available). The criterion for mastery in the random mix phase was five consecutive correct responses, where the new verb had to be asked for at least once. When this criterion was met, the next new verb on the list was probed. If the participant responded incorrectly, the verb was taught following the same procedure as just described. If s/he responded correctly, the next verb on the list was probed or the new verb was done in a mix with other mastered verbs, before the next verb was probed. This procedure was followed until the participant responded correctly to five consecutive novel verbs on the first probe. At the end of each training session, the scores were displayed in a spreadsheet, where the

therapist or supervisor could visually inspect the progress in the teaching and make adjustments if needed. The steps in the procedure are showed in table 3.

Table 3. *The procedure for sufficient exemplar training followed in the current study. The first five steps are show with examples of score and the criterion for when to move to the next step.*

Step	# Verb	Probe (Sd)	Correct response	If correct	If incorrect
1	1 Clap	Shows clapping, pause: "What did I do?"	"Clapped"	Probe next verb on list	Teach until 3 consecutive corrects in massed trial
2	2 Jump	Shows jumping, short pause: "What did I do?"	"Jumped"	Probe next verb on list	Teach until 3 consecutive corrects in massed trial
3	1 and 2	Random mix of 1 Clap and 2 Jump	"Jumped"/ "Clapped"	Teach until 5 consecutive corrects in random order	
4	3 Knock	Shows knocking, short pause: "What did I do?"	"Knocked"	Probe next verb on list	Teach until 3 consecutive corrects in massed trial
5	1, 2 and 3	Random mix of 1 Clap, 2 Jump and 3 Knock	"Jumped"/ "Clapped"/ "Knocked"	Teach until 5 consecutive corrects in random order	
6	4 Wave	Shows waving, short pause: "What did I do?"	"Waved"	Probe next verb on list	Teach until 3 consecutive corrects in massed trial
-	-	Continue this procedure until 5 consecutive new verbs are correct when probed			

Three out of the four participants had a token board and selected their backup reinforcer from pictures of preferred items kept in a folder (e.g., internet time, computer games, or puzzles). During training, all correct responses were followed with praise and a token. Typically, the participants completed two token boards of 10 tokens before they got access to the backup reinforcer. For one of the participants (Gretchen), only social praise followed correct responding. Prompted responses were followed by praise only for all four participants. Incorrect responses were not given any programmed consequence by the therapist, except for Gretchen where an incorrect response was followed by an informational “No” or “Try again”.

Procedural Integrity

For the purposes of the present study, the therapists underwent additional training on the sufficient exemplar teaching procedure and data collection procedures. Scoring was done using a datasheet that allowed each trial to be recorded as either correct, incorrect or prompted. We defined procedural integrity as following the intervention procedure on every teaching trial as outlined above (e.g., probing a new verb when the previous verb was mastered in a mix after training or on the first probe, prompting after a maximum of two incorrect responses). Integrity was calculated by inspecting the trial-by-trial display of the teaching for each of the participants. We calculated integrity by counting the number of breaches in protocol and dividing it by the number of opportunities to breach. The average procedural integrity across all participants was 96% (range 93%-100%).

Inter-observer Agreement

In about 40% of the probes and training sessions, data were collected by both the therapist and an experimenter (first or third author) independent of each other. Agreement was calculated by dividing the number of disagreements by the number agreements plus disagreements and multiplying by 100. Agreement was high with an average of 96% (range 94-100%).

Results

All four participants established the generalized use of past tense regular verbs following intervention. See figure 1. Participant 1, Chris, demonstrated no correct use of the past tense in the 18 verbs that were probed in baseline. Chris started the intervention on the same day as the baseline probes were done. After being taught a total of seven verbs during the intervention phase, he started responding correctly when new verbs were probed and met the criterion for generalized responding (i.e., 5 consecutive correct responses on new verbs), with correct use of the past tense on verb numbers 8 through 13. This criterion was met after a total of 157 trials, and two days of teaching. On the post-test with the same 18 verbs that were tested in baseline, conducted immediately following the intervention phase, he got all correct. A test for generalization across people was conducted on the next day, including 11 of the 18 verbs in the baseline test. He used the past tense correctly on 10 out of 11 correct with a person not involved in the intervention. After about three months, a follow up test was done, that included 16 of the 18 verbs that were tested in baseline. He responded correctly on 10 of the 16 verbs probed. See figure 2.

Participant 2, Roy demonstrated no correct use of the past tense in baseline sessions. He had two baseline sessions two weeks apart, each of them with the same 16 verbs. Like Chris, Roy also needed to be taught 7 verbs before generalized responding to new untrained verbs was observed, and he reached the criterion of responding correctly to 5 consecutive novel verbs 8 through 13. This took 136 trials and 4 days of teaching. Roy responded correctly to all 16 verbs in the post-test. A generalization test could not be performed in Roy's case, but a follow-up test was conducted after 3 months. No correct use of the past tense was observed at follow-up. See figure 3.

Participant 3, Charlie showed no correct use of the past tense in the probes conducted prior to the intervention. Like Roy, Charlie had two baseline sessions two weeks apart, but he had 18 verbs probed in each of the session. Charlie needed training with 5 verbs before he started to generalize to novel verbs, and he met the criterion of responding correctly to verbs 6 through 13, and this took 59 trials, and 3 days of training. Charlie also responded correctly to all 18 verbs in the post-test, in the test for generalization across people, and got 17 out of 18 correct in the follow-up test conducted 3 months later. See figure 4.

Participant 4, Gretchen, demonstrated some correct use of the past tense in baseline. We did baseline tests once a week for 4 weeks. On the first test she got 7 out of 14 verbs correct, on the second 12 out of 17, on the third 7 out of 15 and on the fourth 10 out of 17. Three verbs were consistently correct across all baseline measures and these were excluded from the study. Gretchen only needed training on three verbs before she started to generalize and met criterion for generalized responding with correct responses to verbs 4 through 8. This required 39 trials and one day of teaching. On the post-test, the test for generalization across people and time she got 16 out of 17 correct.

Figure 1. *The number of verbs in each condition are plotted against the top x-axis, and the number of weeks in baseline are plotted against the bottom x-axis. The criterion for mastery in training was 3*

corrects in a row in massed trials, followed by 5 corrects in a random mix of mastered verbs. The intervention phase was stopped when the participant responded correctly to 5 untrained verbs consecutively. The boxes with "Probes" show the results of each verb probed during baseline, post-test, generalization across people, and at follow-up. A solid black circle indicates incorrect responding on the verb probed, whereas a white circle indicates correct responding. The number of trials needed to meet the criterion for mastery of each new verb during training are plotted against the y-axis, and number of verbs trained against the x-axis. When criterion for generalized responding across new verbs was met, this is highlighted in the gray circles (correct usage of at least 5 untrained verbs on first trial).

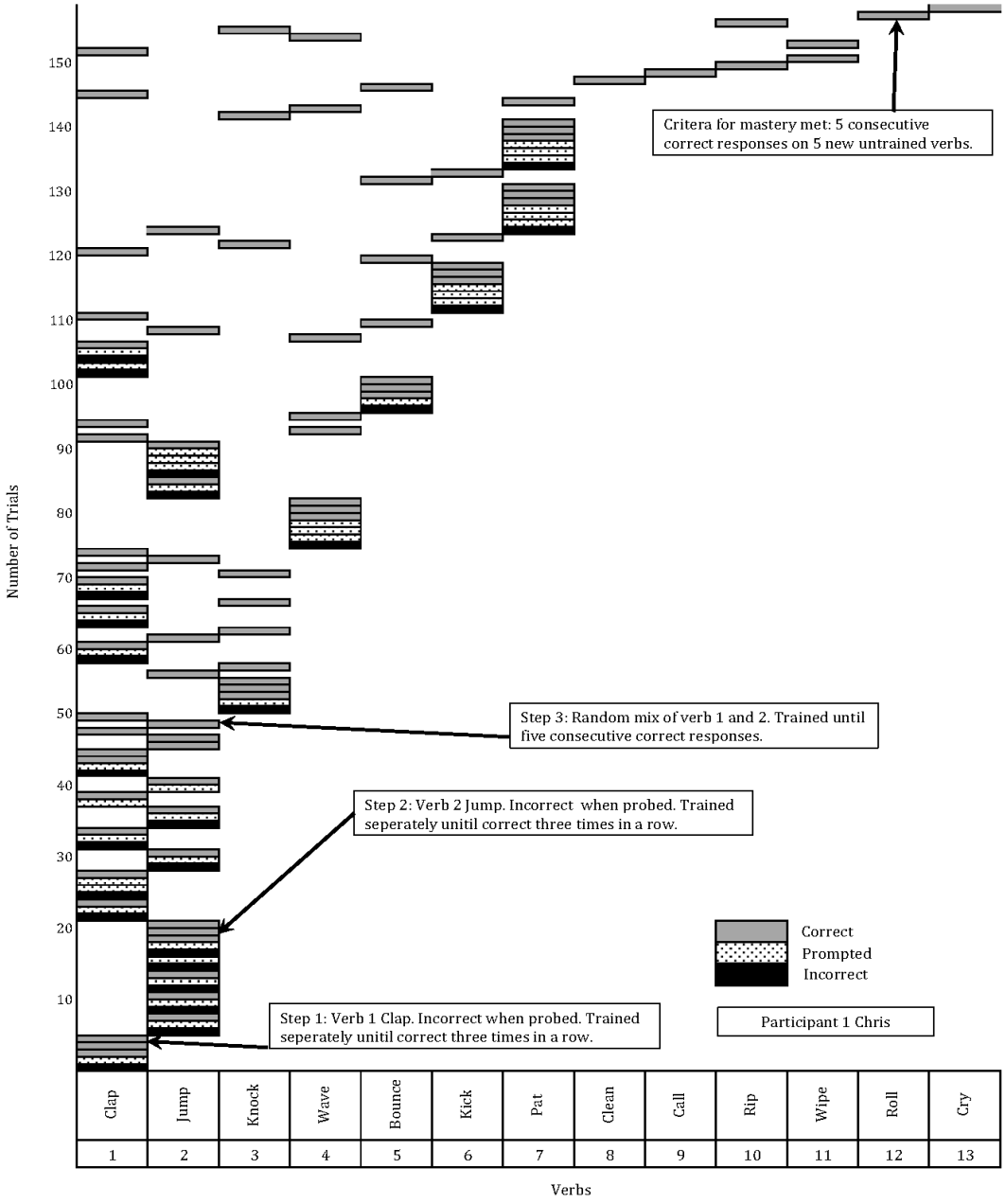

Figure2. *This figure displays the training data for participant 1 Chris. The number of training trials across verbs are plotted against the y-axis, and the verbs included in training are shown on the x-axis.*

The rectangles show the participants response coded as correct (grey), incorrect (black), or prompted (pattern). Three corrects in a row means that criterion was met for mastery in massed trials and five correct responses on untrained verbs means that the criterion is met for generalization.

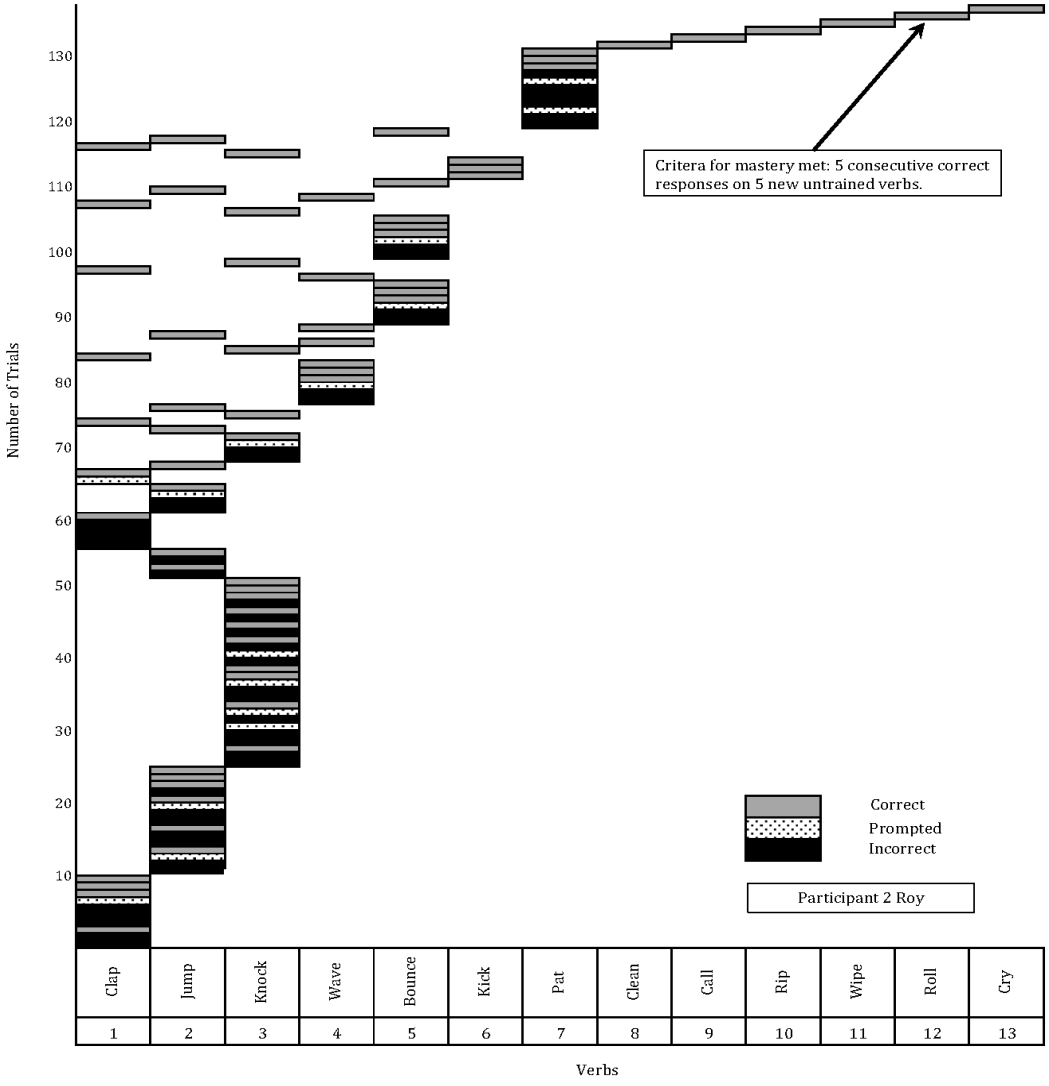

Figure 3. *This figure displays the training data for participant 2 Roy. The number of training trials across verbs are plotted against the y-axis, and the verbs included in training are shown on the x-axis. The rectangles show the participants response coded as correct (grey), incorrect (black), or prompted (pattern). Three corrects in a row means that criterion was met for mastery in massed trials and five correct responses on untrained verbs means that the criterion is met for generalization.*

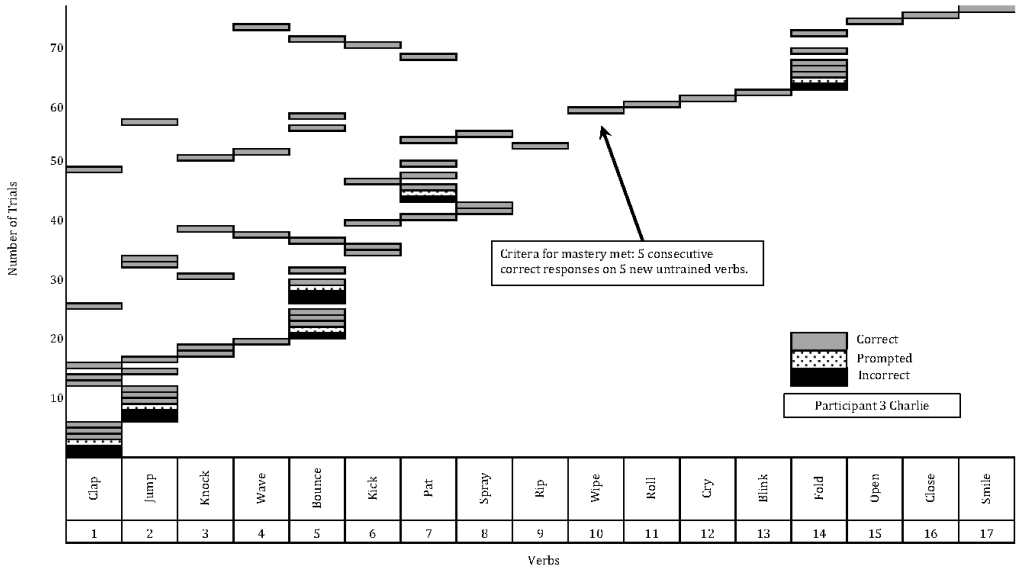

Figure 4. *This figure displays the training data for participant 3 Charlie. The number of training trials across verbs are plotted against the y-axis, and the verbs included in training are shown on the x-axis. The rectangles show the participants response coded as correct (grey), incorrect (black), or prompted (pattern). Three corrects in a row means that criterion was met for mastery in massed trials and five correct responses on untrained verbs means that the criterion is met for generalization.*

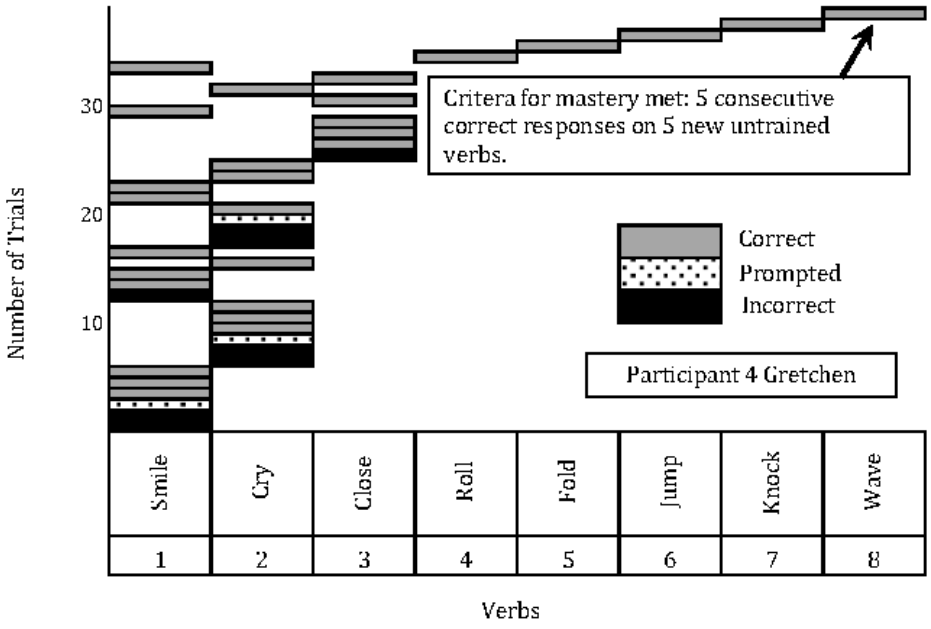

Figure 5. *This figure displays the training data for participant 4 Gretchen. The number of training trials across verbs are plotted against the y-axis, and the verbs included in training are shown on the x-axis. The rectangles show the participants response coded as correct (grey), incorrect (black), or*

prompted (pattern). Three corrects in a row means that criterion was met for mastery in massed trials and five correct responses on untrained verbs means that the criterion is met for generalization.

Discussion

We successfully taught four participants with autism to use regular verbs in the past tense following a sufficient exemplar training strategy. The strategy allowed the therapist to monitor performance on every new verb as it was introduced and to see exactly when transfer to novel untrained exemplars occurred.

Our results suggest that sufficient exemplar training may have some advantages over training in sets of stimuli as in MEI or merely teaching a certain number of verbs which is sometimes suggested in intervention manuals. The protocol used in the present study allowed for a greater degree of individualization in the number of exemplars taught and the stepwise progression in training allowed for individual pacing since mastery of one step was required before the participant was allowed to move to the next step. This can save precious teaching time and avoids unneeded repetition.

The display made it easy to conduct procedural fidelity checks. For instance, it was possible to see if prompts were given on several consecutive trials and if the mastered items were mixed with the target verb. Anecdotal evidence from the therapists was that the display made it easier for them to understand the logic of the sufficient exemplar training strategy they employed.

The specific strategy we employed in this experiment may hold some promise for promoting generalization both within a class and across settings. It is conceivable that the same type of strategy may be used to teach a host of other skills where transfer within a particular class would be logical. This could be other grammatical behavior such as singular and plural forms but also higher order classes such as imitation and matching could be taught following a similar strategy. Indeed, the procedure shares the same logic as that employed by Jahr, Eldevik & Eikeseth (2000) to teach children with autism generalized cooperative play, and Jahr (2001) who taught children with autism to answer novel wh-questions.

It is likely that the teaching of many exemplars (whether it is done as a serial or concurrent strategy) simulates normal language development and that the key element is learning sufficient exemplars.

Based on the literature, it is not clear how to conceptualize the fact that responding generalized to novel verbs and if it is a form of response generalization. Stewart, McElwee, and Ming (2013) argued that this term is used inconsistently and that it does not provide a satisfactory account for how generative performances come about. Instead, these authors proposed that generative language can be best explained as derived relational responding, and that the teaching of multiple exemplars is the underlying process responsible for this. Other authors have described the generalized use of correct verb tenses as an acquired autoclitic operant (Moore, 2008). It seems that further research and theoretical conceptualizations are needed to better understand the phenomenon of generative language. Future studies should investigate whether skills acquired generalize across time and investigate whether generalization to other examples of the same verb will occur (e.g., generalization from opened a box to opened a door). In addition, the particular details of the protocol, such as the criterion for introducing the next probe, need to be validated across a variety of skills and participants. The trial-by-trial data collection and depiction should also be tried and compared with MEI.

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