Running head: PARITY AND EXPLICIT REINFORCEMENT

# Grammatical Constructions in Typical Developing Children:

# Effects of Explicit Reinforcement, Automatic Reinforcement and Parity

Leni Østvik, Svein Eikeseth and Lars Klintwall

Oslo and Akershus University College

## Author Note

Leni Østvik, Pedagogical and Psychological Services for Ål and Hol Municipality. Svein Eikeseth and Lars Klintwall, Department of Behavioral Science, Oslo and Akershus University College.

This study is based on a Thesis submitted by the first author to the Graduate Faculty of Akershus University College in partial fulfillment of the requirements for the degree of Master of Science.

Address correspondence to Svein Eikeseth, Oslo and Akershus University College, P.O. Box 4, St.Olavs plass, N-0130 Oslo, Norway. E-mail: svein.eikeseth@hioa.no

## Abstract

This study replicated and extended Wright (2006) and Whitehurst et al (1974) by examining whether preschool aged children would increase their use of passive grammatical voice rather than using the more age-appropriate active grammatical construction when the former was modeled by an adult. Results showed that five of the six participants began using the passive voice after this verbal behavior had been modeled. For three of the participants, this change was large. The change occurred even though the adult model explicitly rewarded the participant with praise and stickers for using the active voice, while providing no praise or stickers for using the passive form that was modeled. For one participant, the modeling procedure had no effect on use of the passive voice. These results indicate a strong automatic reinforcing effect of achieving parity with the grammatical structures used by adults, compared to the effects of explicit reinforcement by the adult. This might help to explain why children acquire grammatical structures prevalent in their language community apparently without explicit instruction.


Key words: Verbal behavior, modeling, automatic reinforcement, parity, children, imitation

# Grammatical Constructions in Typical Developing Children:
# Effects of Explicit Reinforcement, Automatic Reinforcement and Parity

Skinner (1957) defined language or verbal behavior as an operant behavior that is "reinforced through the mediation of other persons" (p. 2). This refers to a functional relationship between behavior of the speaker and conditions in the speaker's social environment. For verbal behavior to emerge, operant verbal responses must be reinforced by the verbal community (Skinner, 1957). An important question is how this reinforcement occurs.

Researchers have observed that children seem to acquire many language skills apparently in the absence of explicit instruction or explicit reinforcement, and this has been taken to contradict Skinner's analysis of verbal behavior. Brown and Hanlon (1970) presented data showing that although parents often give feedback on some aspects of their children's speech, other aspects are seldom instructed. Specifically, parents tend to provide positive and negative consequences for the content of the statements (e.g. naming objects and actions correctly) while accepting many errors in grammar and pronunciation.

Although this argument was weakened by the work of Moerk (1983), who re-analyzed Brown and Hanlon's (1970) data and showed that their analysis overlooked many contingencies of reinforcement, Moerk was not able to refute Brown and Hanlon's general conclusion. Logically, there are several examples of grammatical distinctions that cannot plausibly be explained by a history of explicit reinforcement. This is simply because most adults are unaware of them. That is, adults respect certain regularities in word order without being able to tact the regularities (Palmer, 1998).

Chomsky (1980) asserted that some special, innate linguistic device accounted for how grammar and other important linguistic skills were acquired in the absence of direct instruction.

Although Chomsky's theory could explain how children are able to speak grammatically without explicit reinforcement, and proposed that this type of neural modulate was established through the process of evolution, the theory suffers from a major problem: It must address how contingencies of survival can select grammatical distinctions. What precisely has been selected and which evolutionary contingences might have selected them (Palmer, 1998).

In Skinner's analysis, the apparent missing source of reinforcement is automatic reinforcement, arising from the child conforming to the behavior of a verbal model. An automatic reinforcer is related to the response in such a way that it is produced directly by the response (Catania, 2007; Novak & Peláez, 2004; Vaughan & Michael, 1982). In other words, reinforcement is not mediated by the action of another person.

This can be illustrated with an example. A girl who hears and sees her big sister whistle will very likely want to whistle as well. She will exhale air and try to shape her mouth the same way as her big sister does. Initially, she will not be able to produce anything resembling the whistling of her model, but gradually, after repeated attempts, the first whistling sounds appear, and the produced sound is likely a powerful reinforcer. If the girl continues to practice whistling, sometimes producing a good imitation and sometimes not, differential and automatic reinforcement will shape her behavior into a skilled whistler.

This example illustrates how imitation and automatic reinforcement might play an important role in the acquisition of verbal behavior. It must be emphasized that this type of imitation is not an echoic verbal behavior, because the verbal response is not produced in immediate temporal relationship to the verbal stimulus (Skinner, 1957, p. 164). Skinner discussed these issues in his text *Verbal Behavior* (e.g., p. 58, 357), including the following:

> Automatic reinforcement may shape the speaker's behavior. When, as a listener, a man acquires discriminative responses to verbal forms, he may reinforce himself for standard forms and extinguish deviant behavior. Reinforcing sounds in the child's environment provide for the automatic reinforcement of vocal forms. …The child can then reinforce himself automatically for the execution of vocal patterns which are later to become part of his verbal behavior. At this stage the child resembles a parrot, which is also automatically reinforced when its vocal productions match something heard in the environment. A similar effect may lead to a special manner of speaking or to particular forms of response characteristic of the behavior of others. The effect is often called identification, but we have no need to appeal to a special process here. The listener usually finds certain speakers particularly reinforcing, either because what is said is reinforcing, or because the speakers are reinforcing in other ways. Parents, favorite employers, persons of prestige, and close friends are examples. Since, for one reason or another, it is often reinforcing to hear such people speak, it is automatically reinforcing to speak *as they speak*—with a particular intonation, mannerism, or favorite vocabulary. Terms characteristic of the adult repertoire are likely to be used by children with special frequency when first acquired. This is not echoic behavior, because the borrowed response is not emitted in the proper temporal relation to the verbal stimulus. The borrowing occurs because of the automatic self-reinforcement generated by the speaker as a result of his earlier conditioning as a listener (Skinner, 1957, p. 164).

Palmer (1996) used the term *parity* to describe how a speaker who is already a competent listener can detect when he or she confirms or deviates from the practice of the verbal community, and hence regulates his or her verbal behavior to match the modeled behavior.

Children usually are competent listeners before they reach the same level as a speaker, and thus they are able to detect even slight differences in verbal utterances (Horne & Lowe, 1996). This means that children can tell whether their own utterances conform or deviate from that of a model. To achieve parity in ones verbal behavior might be a strong generalized reinforcer because achieving parity is highly adaptive in most situations, and not conforming is often punished by the verbal community (Smith, Michael & Sundberg, 1996; Sundberg, Michael, Partington & Sundberg, 1996)

The behavior analytic interpretation of language acquisition is thus based on two types of reinforcement. First, verbal behaviors that are true or false statements (i.e., nouns and verbs) are typically differentially and explicitly reinforced by the language community. Second, speaking in accordance with verbal conventions is automatically reinforced by behaving in parity with adult speech.

To test this hypothesis one could demonstrate that children can acquire novel grammatical conventions in the absence of or in conflict with explicit reinforcement. Given that it is unusual in the verbal behavior of children in many languages, the sentence structure called the “passive voice” is an ideal candidate for such a demonstration.

The passive voice is when the object in a sentence is put before the agent of the verb, such as in “Caesar was murdered by Brutus”. The passive voice construction can be thought of as the opposite of the active voice construction, an example of which is “Brutus murdered Caesar”. Several developmental studies have investigated the use of verbs in the passive voice construction (c.f., Allen & Crago, 1996; Demuth, 1989; Marchman, Bates, Burkardt, & Good, 1991; Trosborg, 1982). The passive voice debut varies widely across different language communities. For instance, studies on Inuit children have indicated that they start using the

passive voice at the age of two years (Allen & Crago, 1996), whilst studies on Hebrew-speaking children have indicated that they begin using the passive voice at the age of eight (Berman, 1985). The explanation for this might be that the passive voice is widely used in the Inuit language, while it is quite rare in Hebrew.

Whitehurst, Ironsmith and Goldfein (1974) investigated the acquisition of the passive voice as a model for how verbal behavior is acquired. Six normally developing English-speaking children between the ages four and five years were exposed to five sessions during which they listened to an adult describing a set of drawings using the passive voice. Next, the children were asked to describe a mix of the same stimuli and novel but similar stimuli. All participants produced sentences in the passive voice to describe at least some of the novel stimuli. The experiment included a control group which did not hear the passive voice modeled by the adult. These children produced no sentences in the passive voice when describing any of the drawings.

In a similar study, Wright (2006) included six English-speaking participants aged three and a half to five and a half years. The participants completed six phases, the first of which was a baseline phase in which children were asked to describe drawings of two animals involved in an activity (e.g., a dog brushing a cat). Phase 2 and 4 were modeling phases, during which the experimenter modeled a description of the first stimulus in pair of drawings, using the passive voice (e.g., “the mouse is being pulled by the elephant” to describe a drawing of an elephant pulling a mouse). The participant was then asked to describe the second drawing in the same pair, which depicted the same animals and the same action with the roles reversed (i.e., a drawing of a mouse pulling an elephant). The experimenter verbally praised use of the active voice but never use of the passive voice. Phases 3 and 5 were test phases, during which the participants were asked to describe novel stimuli without any modeling. In the sixth phase the

participants were asked to describe the same drawings that had been used in the baseline phase. The results showed that participants began to use the passive voice only after the experimenter had modeled this verbal behavior. The results also indicated that the use of the passive voice increased in frequency after repeated modeling. Note that the participants were specifically not reinforced by the experimenter for using the passive voice, and it might thus be assumed that the behavior of the participants was automatically reinforced for using the passive voice.

The present study was designed to systematically replicate Wright (2006). This was done by assessing the extent to which the results of the study could be replicated in a new sample from a different verbal community (Norwegian speaking children). In addition, the present study assessed the children's use of the active voice and undefined verbal behavior in addition to assessing the passive voice. The present study also included explicit tangible consequences for the non-modeled behavior, in order to compare the relative effects of (a) achieving parity with the behavior of a model and (b) tangible consequences. If it can be shown that children acquire novel grammatical forms with only manipulation of the antecedent stimuli (the model behavior) then this would support the behavior analytic interpretation of how children acquire language (Smith, Michael & Sundberg, 1996).

## Methods

### Participants

Seven Norwegian speaking, preschool-aged children participated in the study. Inclusion criteria were as follows; (a) chronological age between three and six years, and (b) no reported history of developmental delays. The participants were recruited from the kindergarten they attended and were, according to the staff, typically developing. Parents of all children in the

kindergarten class received information about the experiment and parents of 12 of the 15 children in the class gave their written consent for participation. The experiment was conducted in one session lasting for approximately 20-30 minutes. All children with parental consent who attended the kindergarten at the day of the experiment participated. The participants' age and sex is shown in Table 1. If a participant in any way expressed or indicated that he or she wanted to quit, the experiment was terminated and the participant was returned to the other children with the toy and stickers earned.

**Setting and Materials**

The experiment was conducted in a room at the kindergarten. The room was used for music lessons and contained a piano, a blackboard, a table, several chairs, and a sofa. Placed on the table were stickers, a plastic sheet (14 x 19 cm) with 20 dots on which the stickers could be placed, an mp3-recording device, a back-up reward, and three sets of drawings on cards (10 x 15 cm). The first two sets of drawings-- the *test* set and the *training* set-- included 20 drawings each (40 pictures in total). Each set of 20 drawings consisted of 10 pairs. Every pair of drawings depicted two animals involved in an activity. In one of the drawings in the pair, animal X was doing something to animal Y, and in the other drawing in the pair, animal Y was doing the same thing to animal X (see Figure 1). The third set, the *generalization* set, consisted of 17 pictures depicting animals involved in an activity. The activities were the same as in the training and test and training sets, but one of the animals was substituted with another one (also taken from the test or training sets) (see Figure 2). The drawings in all sets were the same as those used in Wright (2006), except for the generalization set. For this set, new drawings were made based on the descriptions from Wright (2006).

**Dependent Variable and Reliability**

The dependent variable was the verbal behavior of the children, coded into three categories; passive voice, active voice, and undefined, as follows:

*Passive voice* was defined as any of the following sentences: (a) A sentence containing the passive voice (i.e., X is being done something to by Y, for example, “the elephant is being pushed by the mouse”) in which both subject and object in the drawing are named correctly, (b) a sentence which is structured in the passive voice, but the speaker reverses the naming of the subject and object, (c) a sentence which is structured in the passive voice, but the same animal is named as both subject and object, and (d) a sentence which is structured in the passive voice, but in which the actor is omitted. If the participant named the animal as a similar but different species, such as naming a zebra as a horse or naming a moose as a deer, this was considered correct. The definition of the passive voice was identical to the one used by Wright et al. (2006).

*Active voice* was defined as any of the following sentences: (a) A sentence containing the active voice (e.g., “the mouse is pushing the elephant”) in which both subject and object in the drawing is named correctly, (b) a sentence which is structured in the active voice, but the speaker reverses the naming of the subject and object. (c) a sentence which is structured in the active voice, but the same animal is named as both subject and object, and (d) a sentence which is structured in the active voice, but in which the actor is omitted.

*Undefined Verbal Behavior*. Any other verbal behavior or lack thereof was scored as undefined. The two latter categories (Active and Undefined) were not used by Wright et al., 2006.

Inter-rater agreement was calculated for all participants using the records of two independent observers. Point-by-point agreement was calculated by dividing the number of

agreements by the sum of agreements and disagreements and multiplying the outcome by 100. The mean total inter-rater agreement was 98.9 % (range 98.6 % to 100.0 %).

**Procedure**

The experiment started when the participant was seated in the sofa in front of the table and across from the experimenter. The participant was given a toy and asked whether he or she would like to stay and play a game and earn stickers. If the child would like to leave the experiment, he or she would still get the toy. All participants stayed, and they were shown the stickers that could be earned during the experiment. A total of 20 stickers could be earned. Except during the baseline phase, when no feedback was given, stickers and praise were delivered contingent upon use of the active voice to describe the drawings. Praise or stickers were never given when participant used the modeled the passive voice, or when the participant produced an undefined response. Instead, whenever a participant used the passive voice or produced an undefined response, the experimenter said in a neutral voice, “Now let’s look at the next drawing”, and went on to the next stimulus.

Initially, the experimenter told the participant that he or she would be shown some drawings, and that the participant and the experimenter would take turns describing them. Throughout all six phases, each participant was shown a total of 74 pictures. The experimenter always used the passive voice to describe the stimuli. At the end of the experiment, participants who had not received all 20 stickers were given the remaining stickers.

**Phase 1: Baseline using the test set**. When the experiment began, the participant was given the following instructions: "I would like you to tell me about some drawings that I will show you." The experimenter showed the first stimulus in each pair of the test set, and gave the instruction: "Tell me about this picture". If participants only named the animals on the picture,

the experimenter said, "What are they doing?" If participants did not answer at all, the experimenter said, "Do you know what these animals are called?", and then named the animals for the child. A total of 10 drawings were shown during baseline (saving the second drawing in each set for the final generalization phase), and the experimenter gave only neutral feedback (such as humming and giving a slight nod) regardless of what answers the participant produced.

**Phase 2: Modeling the passive voice using the training set**. During the second phase, the passive voice was modeled. First, the experimenter presented the participant with the first drawing of the training set and described it by using the passive voice. For example, the experimenter showed the participant the drawing exhibited in the top panel of Figure 1 and said: "The mouse is pulled by the elephant". The picture was held in front of the child for 10 seconds after which the experimenter said, "Great, you waited your turn", and removed the picture. If the participant tried to imitate the experimenter during the 10-second-interval, the experimenter told the participant not to say anything before it was his/her turn. After two seconds, the experimenter presented the second stimulus in the pair (see lower panel of Figure 1) and told the participant; "Now it's your turn, tell me about this picture". All 20 drawings in the training set were presented in this phase; one drawing of the pair was modeled by the experimenter, whereas the other drawing of the pair was described by the participants.

Praise and stickers were presented contingent on the participant waiting his or her turn and using the active voice when describing the drawings. The experimenter never praised or delivered any stickers if the participant used the passive voice, nor did the experimenter in any way indicate that the passive voice was the sought-after response.

**Phase 3: Testing the passive voice using the generalization set.** During phase 3, the use of the active and passive voices in response to the pictures in the generalization set was

assessed. The participants were shown a drawing and given the instructions: "Tell me about this picture". The experimenter waited 10 seconds for the participant to respond. After a two-second-pause the next stimulus was presented. Rewards were provided by the same criteria as described in phase 2. The participant was shown a total of 17 pictures during this phase.

**Phase 4: Modeling the passive voice using the training set.** Phase 4 was identical to phase 2.

**Phase 5: Testing the passive voice using the generalization set.** Phase 5 was identical to phase 3.

**Phase 6: Testing the passive voice using the test set.** During phase 6, the use of the active and passive voices in response to drawings from the test set was assessed. The experimenter presented the second (and novel) drawing from the pairs in the test set and asked participants to describe it. Each participant described a total of 10 pictures. The procedure for reinforcement was the same as in the other phases.

**Procedural Integrity**

The experimenter kept, during the entire experiment, a laminated sheet with a description of the experimental procedure and the instructions to be given to the participants. This was done to ensure that the experiment was carried out according to the protocol. All drawings had the correct description, in the passive voice, printed on the back side of the card. This ensured a correct passive voice modeling of the drawings during the training phases, and helped the experimenter provide correct feedback and correct scoring of the participants' responses.

To assess procedural integrity, the audio recordings of phase 2 for the second participant, phase 3 for the third participant and phase 4 for the fourth participant were scored for procedural integrity. Scoring was based on whether the experimenter produced the correct instructions to the

participant in the beginning of each phase, whether the experimenter described the drawings in accordance with what was written on the back of each picture, whether the experimenter gave the correct instructions, and whether the experimenter gave feedback in accordance with the contingency described above. Procedural integrity was found to be 97 %, containing only one error: a participant was given praise once following use of the passive voice.

## Results

The first participant in the study left the experimental room after completing baseline, and hence was excluded from data analysis. The remaining six children completed the experiment in its entirety. Percentage use of passive voice across all phases for each participant is shown in Figure 3. As can be seen, no participant used the passive voice during baseline.

Results for Eskil are shown in Figure 3 and Table 2. During baseline, Eskil used the passive voice on 0% of the trials (he used 100% active voice). In the subsequent training phase, he used passive voice on 80% of the trials (20% active voice). In the first test phase (phase 3) the passive voice was used in 53% of the trials (41% active voice). In the second training phase (phase 4) the passive voice was used on 100% of the trials, and in the next test phase (phase 5) the passive voice was used for 59% of the trials (35% active voice), and in the final generalization phase the participant used the passive voice in 70% of the trials (30% active voice).

The results for Simon and Frode were similar to that of Eskil (see Figure 3 and Table 2), and hence, the verbal behavior of Eskil, Simon and Frode appeared to be affected by the modeling condition.

David, by contrast, failed to use the passive voice throughout the experiment (see Figure 3). As shown in Table 2, David used the active voice on 40% of the trials during baseline, and

undefined responding during the remaining 60% of the baseline trials. During the two subsequent training phases (2 and 4), David used the active voice on 80% of the trials, and during the final generalization phase he used the active voice on 100% of the trials. As can be seen in Figure 3 and Table 2 the results of Henny and Amanda were similar to that of David, though both Henny and Amanda began using some use of the passive voice. Hence, the verbal behavior of David appeared unaffected by the modeling condition, whereas the modeling condition had some effect on the verbal behavior of Henny and Amanda.

## Discussion

This study replicated and extended Wright (2006) and Whitehurst et al. (1974) by examining whether preschool aged children would increase their use of the passive grammatical voice when it was modeled by an adult, rather than using the active grammatical construction, which was explicitly reinforced.

Results showed that five of the six participants began using the passive voice after this verbal behavior had been modeled. For three of the children this change was large and persistent into the final generalization phase. The modeling procedure had a limited effect on the verbal behavior of two of the participants, who continued to use the active voice on most of the trials though they sometimes also used the passive voice. Finally, one participant never used the passive voice. During baseline he used 60% undefined responding and 40% active voice, and during the final generalization phase he used 100% active voice. Hence, he acquired the use of the active voice (rather than the modeled passive voice) over the course of the experiment.

In the final generalization phase of the experiment, the participants were asked to describe drawings in which the previous animals and actions were presented in new combinations. The drawings in the generalization set were different from the drawing in the

training and test sets as follows: The training and test sets consisted of pairs of animal X doing something to animal Y, and then with the roles reversed. The generalization set consisted of animals and actions from the earlier sets but with a new object animal. The object animals was also taken from the training and test sets, but had not been combined with that agent animal or action. During the final generalization phase, four of the participants generated new sentences in the passive voice, suggesting that the increase or establishment of the passive voice was a matter of learning an autoclitic or intraverbal frame, rather than simple imitation.

The main question of the study was to investigate whether children could learn a novel verbal behavior with the manipulation of antecedents only, not consequences. The increase of the use of the passive voice is indicative that this was the case, but is limited by the possible explanation that the children already had this grammatical frame in their repertoire and that the modeling only increased the strength of that frame. Simply put, it cannot be determined empirically from the present study whether the increase in the use of the passive voice was a matter of acquisition of novel behavior, or only a matter of strengthening existing verbal behavior. Either way, the results suggest that the verbal behavior of children is affected by the verbal behavior of a speaker, presumably through automatic reinforcement and parity.

A limitation of this study was that it lacked a control group. Hence, maturation and reactivity of the probes may be confounding variables that cannot be ruled out empirically. However, it is unlikely that maturation could account for the change observed in the participant's verbal behavior, since the experiment was conducted in one session, and since all participants failed to use the passive voice during baseline despite varying in age from three years, five months to five years, five months. Also, it is unlikely that reactivity of testing could account for the acquisition of the passive voice since the participants were rewarded for using the active

voice. Also, Whitehurst et al. (1974) included a no-treatment control group in their study, and none of the participants in the control group used the passive voice at any point over the course of the experiment. This observed stability of the active voice occasioned the design of the present study. Alternatively, a single-case design, such as a multiple baseline design, could have been used.

Interestingly, the three participants for whom the modeling condition had the largest effect were on average six months older than the other three children. It is possible that for these children, the automatic reinforcement produced by achieving parity had higher valence than the praise and stickers given contingent on use of the active voice. For the younger children, the opposite could have been the case. However, it should be noted that no reinforcer assessment was conducted on the stickers or the praise. It is possible, though unlikely, that neither stickers nor praise functioned as reinforcers for some of the participating children. Another possibility is that delivery of praise and reinforcers contingent on turn-taking lead to satiation for these stimuli as reinforcers.

Future studies could investigate the extent to which participants would use the passive voice, after modeling, on novel drawings in which neither subjects nor activities had been previously modeled. Future studies could also model other grammatical frames than the passive voice. This could be frames that do not exist or are extremely unusual, such as “Murdered by Brutus, Caesar” or “Brutus Caesar murdered.” Another possibility is to model an artificial pronunciation of a familiar word. If such artificial verbal responses can be established in the verbal behavior of children, this would suggest that certain aspects of language indeed can be learned through automatic reinforcement and parity.

This study highlights the need to consider both explicit social reinforcement as well as automatic reinforcement when studying the acquisition of verbal behavior.

References

Allen, S. E., & Crago, M. B. (1996). Early passive acquisition in Inuktitut. *Journal of Child Language, 23*, 129-155.

Brown, R & Hanlon, C. (1970). Derivational complexity and order of acquisition in child speech. In J. R. Hayes (Ed.), *Cognition and the development of language* (pp. 11-53). New York: Wiley.

Berman, R. A. (1985). The acquisition of Hebrew. In D. Slobin (Ed.), *The crosslinguistic study of language acquisition* (Vol. 1, pp. 255-371). Hillsdale, NJ: Erlbaum.

Catania, A. C. (2007). *Learning* 4th ed. New York: Sloan Publishing.

Chomsky, N. (1980). *Rules and representations*. New York: Columbia University Press.

Demuth, K. (1989). Maturation and the acquisition of the Sesotho passive. *Journal of the Linguistic Society of America, 65*, 56-80.

Horne P. J., & Lowe, C. F. (1996). Naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior, 65*, 185-241.

Marchman, V. A., Bates, E., Burkardt, A., & Good, A. B. (1991). Functional constraints of the acquisition of the passive: toward a model of the competence to perform. *First Language*, 11, 65-92.

Moerk, E. L. (1983). A behavior analysis of controversial topics in first language acquisition: Reinforcement, corrections, modeling, input frequencies, and the three-term contingency. *Journal of Psycholinguistic Research, 12*, 129-155.

Novak, G., & Peláez, M. (2004). *Child and adolescent development : a behavioral systems approach*. Thousand Oaks, CA: Sage Publications.

Palmer, D. C. (1996). Achieving parity: The role of automatic reinforcement. *Journal of the Experimental Analysis of Behavio*r, *65,* 183–353.

Palmer, D. C. (1998). The speaker as listener: The interpretation of structural regularities in verbal behavior. *The Analysis of Verbal Behavior*, *15*, 3–16.

Skinner, B. F. (1957). *Verbal Behavior*. Englewood Cliffs, NJ: Prentice-Hall

Smith, R., Michael, J., & Sundberg, C. A. (1996). Automatic reinforcement automatic punishment in infant vocal behavior. *The Analysis of Verbal Behavior, 13,* 39-48.

Sundberg, M. L., Michael, J., Partington, J. W., & Sundberg, C. A. (1996). The role of automatic reinforcement in early language acquisition. *The Analysis of Verbal Behavior*, *13*, 21-37.

Trosborg, A. (1982). Reversibility and the acquisition of complex syntactic structures in 3- to 7-year-old children. *First Language, 3,* 29-54.

Vaughan, M. E. & Michael, J. (1982). Automatic reinforcement: An important but ignored concept. *Behaviorism, 10,* 217-227.

Whitehurst, G. J., Ironsmith, M., & Goldfein, M. (1974). Selective imitation of the passive construction throught modeling. *Journal of Experimental Child Psychology, 17,* 288-302.

Wright, A. N. (2006). The role of modeling and automatic reinforcement in the construction of the passive voice. *The Analysis of Verbal Behavior*, *22*, 153-169.

Table 1.

*Participants' sex and chronological age.*

| Participant | Sex | Age (year, months) |
|---|---|---|
| Eskil | M | 4,6 |
| Henny | F | 4,6 |
| Simon | M | 4,0 |
| Amanda | F | 4,3 |
| David | M | 3,5 |
| Frode | M | 5,5 |

Table 2.

*Participants' Use of Active Voice and Undefined Verbal Behavior acrossPhases as Percentage of Trials*

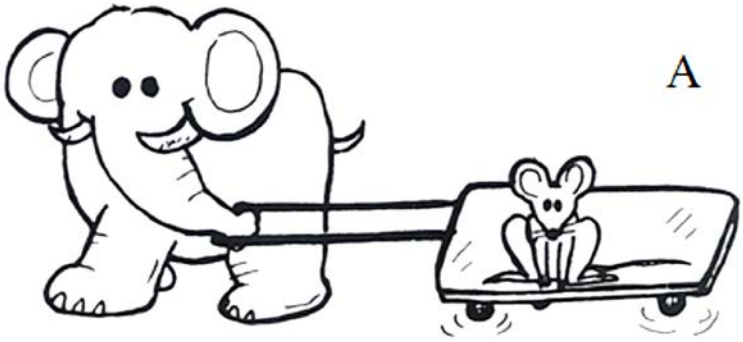
| | Active voice / undefined verbal behavior | | | | | |
|---|---|---|---|---|---|---|
| Participants | Baseline | Modeling | Test | Modeling | Test | Generalization |
| Eskil | 100 / 0 | 20 / 0 | 41 / 6 | 0 / 0 | 35 / 6 | 30 / 0 |
| Henny | 80 / 20 | 80 / 0 | 65 / 0 | 70 / 0 | 76 / 0 | 80 / 0 |
| Simon | 100 / 0 | 60 / 0 | 82 / 0 | 20 / 0 | 18 / 0 | 10 / 0 |
| Amanda | 80 / 20 | 100 / 0 | 94 / 0 | 80 / 0 | 6 / 0 | 100 / 0 |
| David | 40 / 60 | 80 / 20 | 35 / 65 | 80 / 20 | 65 / 35 | 100 / 0 |
| Frode | 80 / 20 | 30 / 10 | 82 / 6 | 10 / 0 | 65 / 12 | 40 / 0 |

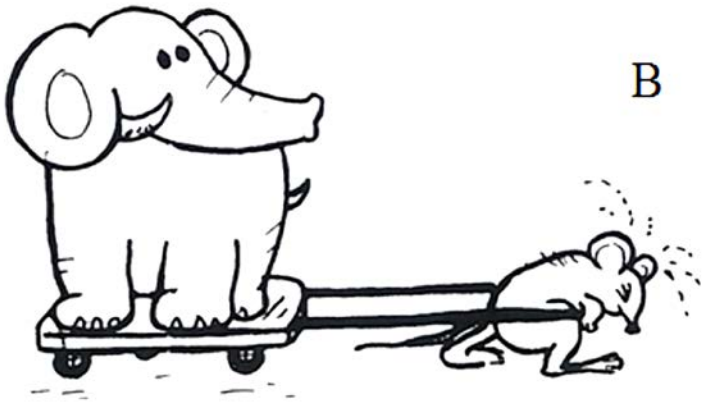
Figure Captions

**Figure 1.** A pair of pictures from the training set. Picture A would be described in the active voice as “The elephant is pulling the mouse”. In passive voice A would be described as: ”The mouse is being pulled by the elephant.” Picture B would be described in the active voice as “The mouse is pulling the elephant” and in the passive voice as “The elephant is being pulled by the mouse.”

**Figure 2**. A pair of pictures from the generalization set. These drawings depict the same activity as those in Figure 1. The elephant in drawing A has been replaced with a panda bear, and the mouse in drawing B has been replaced with a sheep.

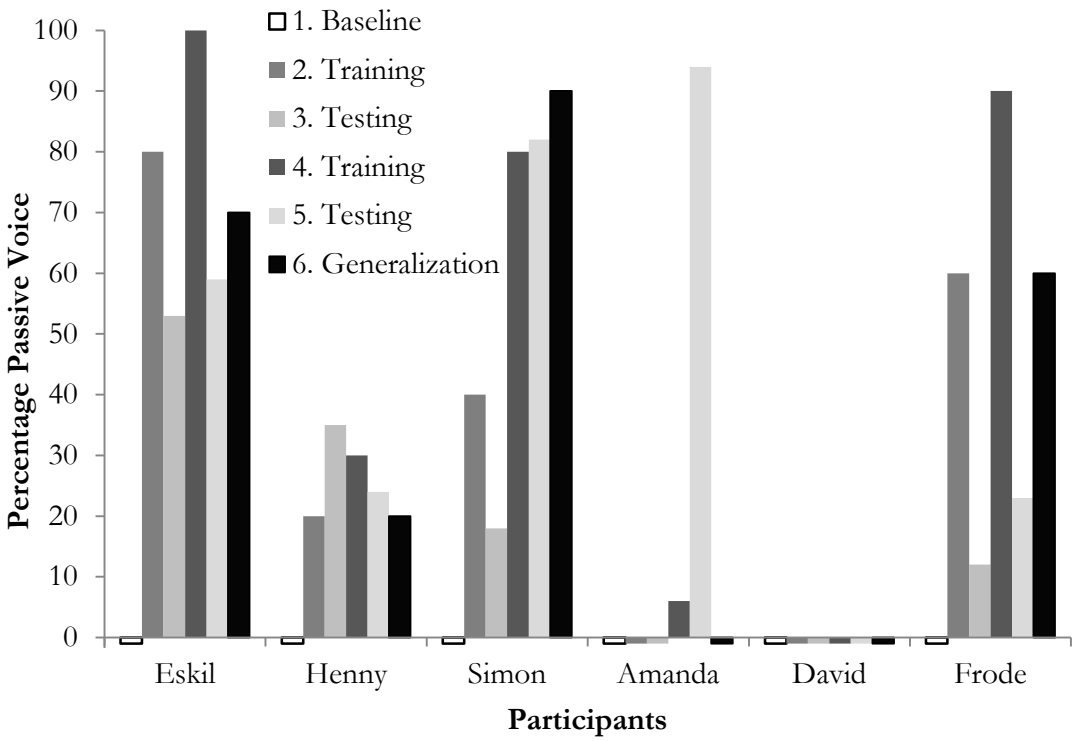
**Figure 3**. Percentage of responses in the passive voice across phases for each participant.


A


B

A

B


1. Baseline
2. Training
3. Testing
4. Training
5. Testing
6. Generalization
Percentage Passive Voice
100
90
80
70
60
50
40
30
20
10
0
Eskil
Henny
Simon
Amanda
David
Frode
Participants