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Automatic Reinforcement and Automatic Punishment in Infant Vocal Behavior

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Two female infants, aged 11 and 14 months, were exposed to a procedure in which an experimenter-emitted vocal response was paired with an established form of reinforcement (positive condition). One of the subjects was also exposed to a procedure in which an experimenter-emitted vocal response was paired with a neutral stimulus (neutral condition), and a procedure in which an experimenter-emitted vocal response was paired with a mild aversive stimulus (negative condition). An AB design was used with pre- and post-pairing measures. The results showed that after the positive pairing the targeted responses increased in frequency in 75% of the sessions. Responding remained constant during the neutral condition, but dropped sharply in the negative condition. These data suggest that a critical variable related to an infant's native language acquisition is the stimulus-stimulus pairing process that occurs when parents or caretakers speak to their infants.

Hart and Risley (1995) recently demonstrated that there is a strong correlation between the frequency of a parent's child-directed verbal behavior, and the frequency of that child's verbal behavior. Children who talked a lot had parents who talked to them a lot, and children who talked very little had parents who talked to them very little. These findings suggest that there are specific aspects of a child's language environment that can be identified as directly relevant to language acquisition. However, there still remains a substantial amount of disagreement as to the exact role that the environment plays in natural language acquisition.

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Theorists in the fields of psycholinguistics and cognitive psychology prefer to explain the emergence of an infant's early vocal and language skills as primarily a function of an infant's innate cognitive and biological abilities (e.g., Slobin, 1979; Pinker, 1994). The environment is not completely neglected, but its significance is frequently overshadowed by cognitive mediators and abstract physiological processes (e.g., mapping, neural networks). It is common within these fields to view behavioral theory as inadequate for the explanation of the emergence of a child's native language skills. Some have even provided research as a basis for their contention that reinforcement theory is incomplete, if not inaccurate (e.g., Brown, 1973; de Villiers & de Villiers, 1979; Piaget 1951; Savage-Rumbaugh et al., 1993).

However, as Salzinger (1994) pointed out in his review of Moerk's (1992) work, it

was Brown's restrictive definition of reinforcement as the contrived and programmed delivery of a specific item following a targeted response, that led him to reject reinforcement as a significant cause of language acquisition. A similar restrictive definition of reinforcement also led Savage-Rumbaugh et al. (1993) to reject reinforcement as a critical independent variable in their explanation of ape language acquisition (Sundberg, 1996). In fact, many of the current arguments in the literature concerning language acquisition are based on incorrect interpretations of behavioral concepts. Chomsky's (1959) infamous review of Skinner's (1957) book *Verbal Behavior* exemplifies the degree to which the behavioral position on language acquisition can be misunderstood.

In addition to using a restrictive definition of reinforcement, many of those who argued against the behavioral position did not consider the possible relevance of automatic reinforcement. However, several researchers (e.g., Bijou & Baer, 1965; Mowrer, 1950; Osgood; 1953; Skinner, 1957) have suggested that automatic reinforcement also plays an important role in an infant's acquisition of a native language. Automatic reinforcement is different from deliberate and directly mediated reinforcement in several ways. Perhaps most important is that in automatic reinforcement behavior may be strengthened in two additional ways, neither of which require the deliberate action of another person.

These two ways have been identified as practical and artistic/autistic by Skinner (1957), and elaborated on by Vaughan and Michael (1982). In the practical type of automatic reinforcement the consequence may be a natural outcome of the direct effects of the behavior on the environment (e.g., the behavior of pushing a door is automatically reinforced by the door opening). In the autistic/artistic type a neutral stimulus acquires reinforcing value through its association with an established form of reinforcement, and any response the produces a response product that resembles that previously neutral stimulus will be automatically reinforced. An example of this type of conditioning occurs when a mother's verbal behavior becomes reinforcing because it is associated with other strong reinforcers. The child's later production of similar sounds is automatically reinforcing because of their association with reinforcement (e.g., food, warmth). The mother typically does not systematically reinforce the child's vocalizing, rather the child's reproduction of some aspects of her speech is automatically reinforcing in that "it sounds good" to sound like one's mother.

Skinner (1957) identified the importance of automatic reinforcement in the natural shaping of infant vocal behavior by pointing out that the

> child is reinforced automatically when he duplicates the sounds of airplanes, streetcars, automobiles, vacuum cleaners, birds, cats, dogs, and so on. But among the sounds which become important are the verbal responses of his parents and others. 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 reinforced when its vocal productions match something heard in the environment. (p. 164)

The current study is an attempt to further explore the concept of automatic reinforcement, and its relation to infant language acquisition, with a replication and extension a previous study on this topic (Sundberg, Michael, Partington, & Sundberg, 1996[1]). Sundberg et al. (1996) demonstrated that several children could acquire new vocal responses through a procedure that involved the pairing of specific sounds and words with established forms of reinforcement. The children acquired several new responses without the use of direct reinforcement or echoic prompts, and emitted these responses quite frequently. In addition, these authors found that with two subjects the pairing procedure evoked an untrained mand, and with one subject the procedure appeared to facilitate the acquisition of an echoic response. These data suggest that automatic reinforcement may play an important role in early language language.

[1]Portions of this study were conducted in 1979 and presented at the 5th Annual Association for Behavior Analysis Convention, Dearborn, MI.

Given the often robust effects of automatic reinforcement, what might the effects of automatic punishment be on verbal behavior? Skinner (1957) pointed out that if vocal behavior is paired with the aversive stimuli associated with conditioned and unconditioned punishment, it may result in a decrease in vocal behavior. The punishment may be mild, but it may still result in the suppression of vocal behavior. Pairings with strong aversive stimuli may often occur in cases of child abuse, and may severely affect a child's language development by making the emission of some vocal responses extremely aversive. It may also be reasonable to speculate that the absence of positive pairing, as in certain cases of child neglect, would negatively affect vocal and verbal development as well. It is possible that these two environmental variables (i.e., aversive pairing and the lack of positive pairing), along with direct punishment and direct extinction, may explain some severe cases of language disorders.

The procedure for establishing a neutral stimulus as an automatic punisher is identical to the procedure for establishing a neutral stimulus as an automatic reinforcer, except a neutral stimulus is paired with a form of punishment. This type of pairing undoubtedly occurs in an infant's natural environment. For example, an infant may be bumped or scratched accidentally by the mother while she is speaking to the child. It is possible that as a result of this pairing, some aspect of human speech becomes a conditioned punisher, and as result it would be automatically reduced upon emission. It would seem quite important to determine if such a pairing would have an effect on an infant's tendency to babble specific sounds.

Therefore, the current study was designed to examine the effects of three different pairing procedures on infant vocal behavior. In addition to the positive pairing used by Sundberg et al. (1996), an experimenter-emitted vocal response was also paired with a neutral stimulus (neutral condition), and with a mild aversive stimulus (negative condition).

METHOD

Subjects

Two female children, ages 11 months (Subject 1) and 14 months (Subject 2) served as subjects. The children appeared to be normal in all aspects of development. These children were chosen for the study because one of the experimenters (the children's father) functioned as a strong form of conditioned reinforcement for the children (an apparent prerequisite for the pairing procedure with young children). In addition, the children did not engage in any forms of escape of avoidance behaviors when attempts were made to work with them.

Setting and Materials

For both subjects the study was conducted in their own home. For Subject 1 the study was conducted in an area measuring approximately six feet by eight feet in the living room. For Subject 2 the study was conducted in the child's bedroom. Play materials consisted of books, plastic kitchen items, a watch, squeeze toys, a cassette tape player, and a data sheet. Sessions were run once per day for Subject 1, (the 11 month old) and twice a day for the second subject (the 14 month old). The mother of the second subject was present during all the sessions.

Response Definition, Recording System, and Design

The subjects' vocal responses were recorded and classified as the targeted vocal response, or a non-targeted identifiable vocalization. Only recognizable phonemes were recorded, other sounds such as those produced by random movement of the vocal muscles or reflexive vocalizations were not recorded. Specific phonemes were used as the target response. All but one of the targeted phonemes had occurred at some point in the children's vocal play repertoire. Utterances were recorded in time bins of 10 seconds for both subjects. The study employed an AB design that compared the subjects' performance on pre-test (baseline)

and post-test measures, with a replication across phonemes and subjects.

Procedure

Three different pairing procedures were examined. The first procedure consisted of a neutral condition where a phoneme was presented, but specifically not followed by reinforcement or punishment. The second procedure consisted of pairing a specific phoneme with an established form of reinforcement (the positive condition). This procedure was conducted with both subjects. And the third procedure consisted of pairing a phoneme with a mild aversive stimulus (the negative condition). Only Subject 1 participated in the negative and neutral conditions.

Neutral Condition

Pre-pairing. The subject was placed in the play area with toys and allowed to play for several minutes. The experimenter, sitting next to the subject, began to continuously record all vocalizations emitted. A tape player also recorded the vocalizations and the two records were compared immediately after each session. Discrepancies resulted in a change in the experimenter-recorded data.

Neutral presentation. The experimenter attended to the infant and the toys were moved aside. Then the experimenter emitted an individual phoneme an average of 16.7 times per minute, but did not follow the sound with any known forms of reinforcement.

Post-pairing. The toys were returned and the experimenter began recording all vocalizations made by the child. The conditions were identical to those in the pre-pairing observation.

Positive Condition

All the conditions were the same as those in the neutral condition, except that the experimenter-emitted phoneme was followed by an established form of reinforcement (e.g., bubbles, tickles). A total of 11 positive-pairing sessions were conducted with Subjects 1, and 5 sessions were conducted with Subject 2. Specific phonemes were selected based on the observation that the child had emitted them before, but did not emit them, or they occurred at a low rate, during the pre-pairing observation. One session with Subject 1 involved an attempt to establish a novel phoneme.

Pre-pairing. The conditions were the same as the neutral condition.

Pairing. The toys were moved aside and the experimenter began the pairing procedure. Each pairing trial consisted of the experimenter saying the targeted phoneme and immediately following it with the delivery of reinforcement. The experimenter's responses were not contingent upon the subject's behavior (e.g., eye contact was not required). When the child emitted vocalizations during this period special care was taken not to accidentally reinforce them. Such reinforcement was prevented by initiating a fifteen second time-out period immediately after a vocal response. This was unnecessary after the first session with the first subject since the child characteristically did not emit vocalizations while others were speaking. Subject 2 did not emit any vocalizations during this condition.

Post-pairing. The toys were returned and the experimenter began recording all vocalizations made by the child. The conditions were identical to those in the pre-pairing observation.

Negative Condition

Pre-pairing. The conditions were the same as the previous conditions.

Pairing. The toys were moved aside and the experimenter emitted a specific phoneme immediately followed by presenting an established form of punishment (the verbal reprimand "Bad girl" which was an established form of conditioned punishment). The experimenter-emitted phoneme was paired an average of 5 times in 20 seconds for the three sessions with Subject 1.

Post-pairing. The toys were returned and the experimenter began recording all vocalizations made by the child. The conditions were identical to those in the pre-pairing observation.

Observation and Reliability

The first author conducted all the sessions and recorded the data in a notebook during each session. A cassette tape recorder was used to record each session in its entirety. An assistant transcribed the tape after each session and the results were compared to the experimenter's recorded data for two factors: (1) agreement of specific response topography, and (2) correct placement of recorded responses with respect to the 10-second time bins. Disagreement resulted in reviewing the tape recording until agreement was reached.

RESULTS

Each condition produced a different effect. The neutral condition had little effect of the rate of the targeted vocalization. The positive condition produced a sharp increase in the targeted behavior for both subjects in 12 out of the 16 pairings. And the negative condition resulted in an immediate decrease of all vocal behavior in all three pairings.

Neutral condition. The presentation of a phoneme alone did not result in an increase in the infant's emission of that phoneme. A representative sample of one of the two neutral sessions with Subject 1 is presented in Figure 1 (for this figure and all other figures, the results are presented in time blocks of 1 minute). During the pre-pairing observation Subject 1 emitted the targeted response ("da") 4 times in 5 minutes (.8 responses per minute), and 16 other vocalizations (mostly "ah" and "oh"). The subject's overall average response rate was 4 vocal responses per minute. The phoneme "da" was then presented 39 times in 160 seconds, but was not followed by reinforcement. During the post-pairing observation the targeted phoneme was emitted a total of 6 times in 5 minutes, with an average rate of 1.2 responses per minute. The

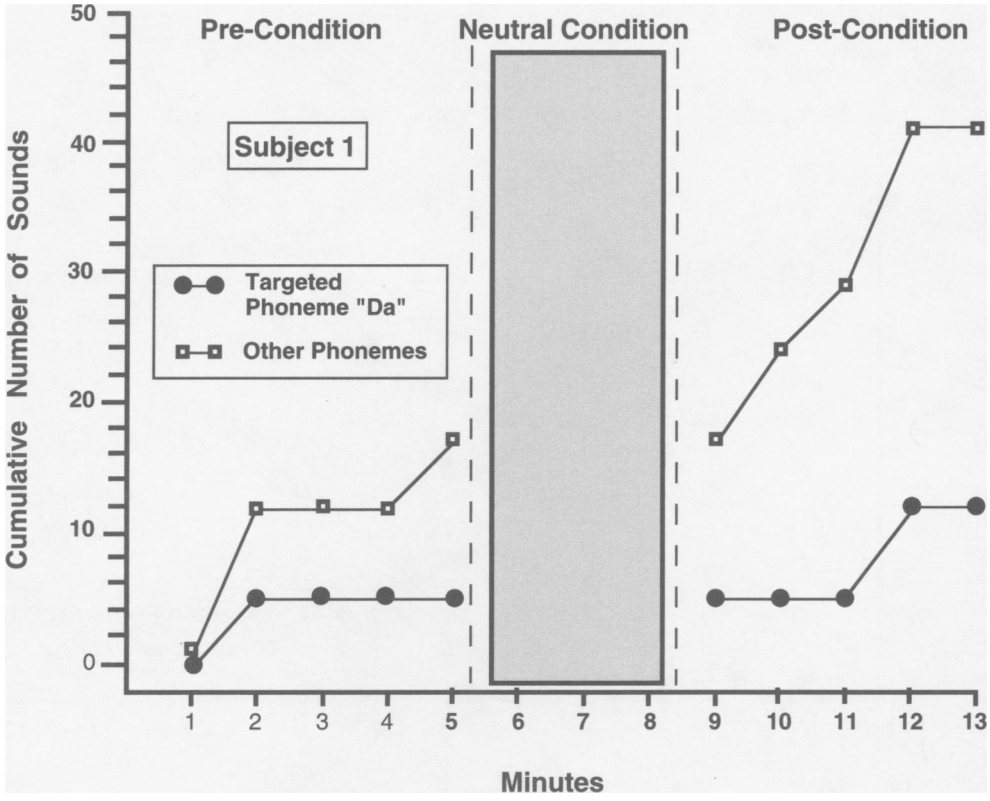

Fig. 1. The neutral condition. The cumulative number of all understandable phonemes for Subject 1 on pre- and post-pairing measures. The shaded area represents the time during which one phoneme ("da") was presented without being followed by reinforcement.

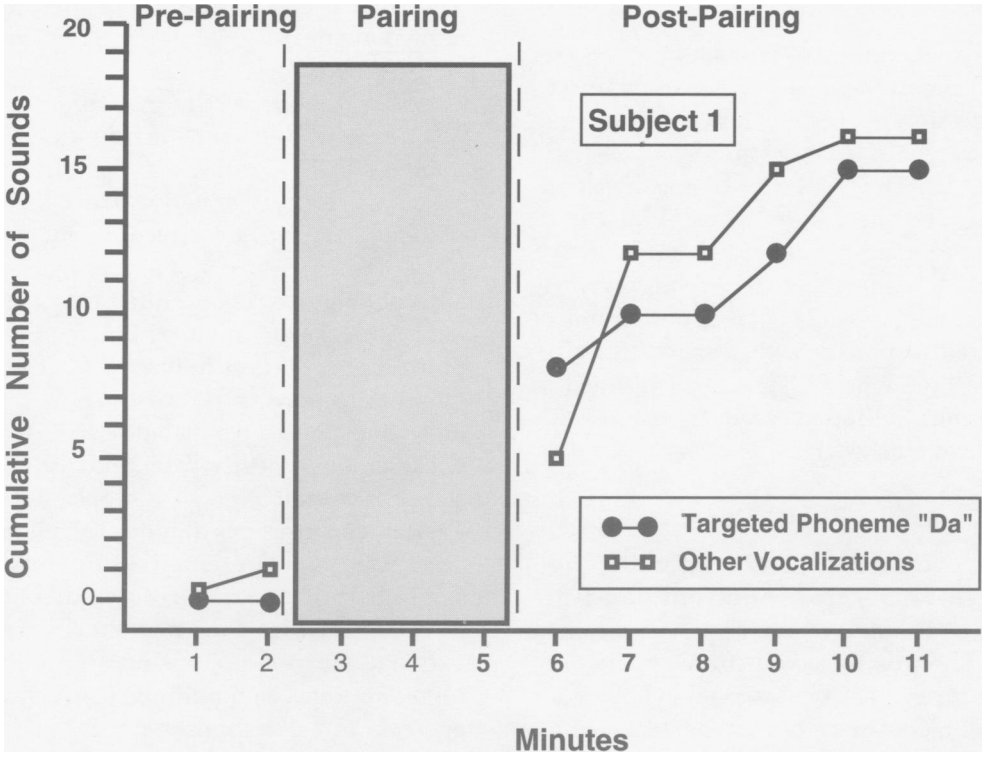

Fig. 2. The positive condition. The cumulative number of all understandable phonemes for Subject 1 on pre- and post-pairing measures. The shaded area represents the time during one phoneme ("da") was paired bubble play.

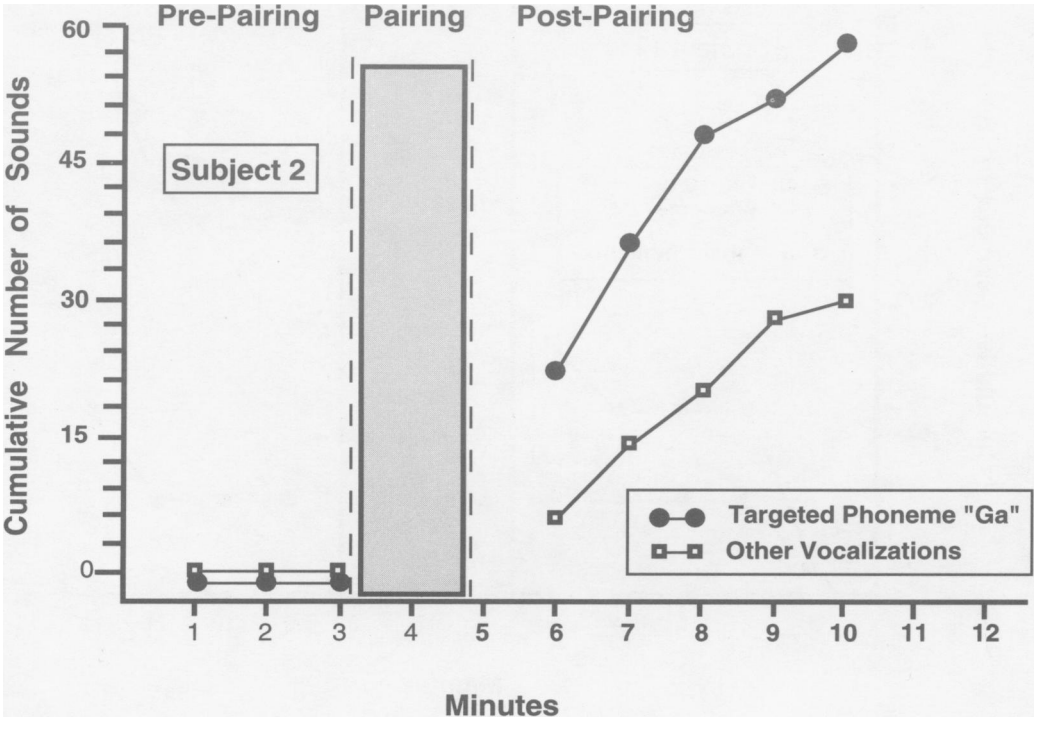

Fig. 3. The positive condition. The cumulative number of all understandable phonemes for Subject 2 on pre- and post-pairing measures. The shaded area represents the time during one phoneme ("ga") was paired bubble play.

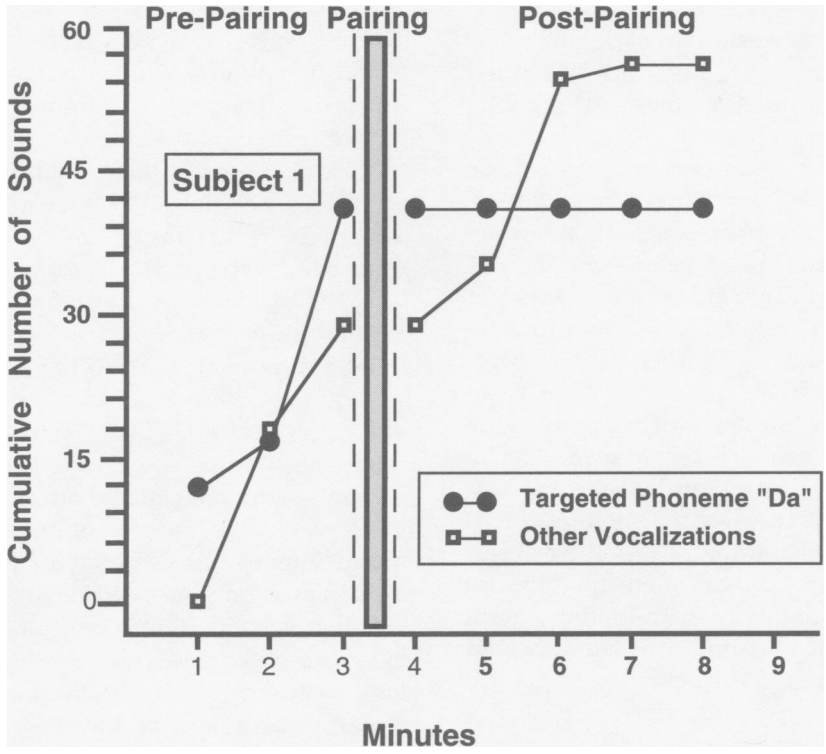

Fig. 4. The negative condition. Cumulative number of all understandable phonemes for Subject 1 on pre- and post-pairing measures. The shaded area represents the time during which one phoneme ("da") was paired with the sternly spoken reprimand "Bad girl."

subject also emitted 30 other vocalizations (primarily "ah" and "ma"), resulting in an overall increase in the subject's rate of vocalization to 7.2 responses per minute.

Positive condition. The positive pairing procedure resulted in the immediate emission of the targeted response for both subjects in 12 out of the 16 pairings (8 out of 11 for Subject 1; and 4 out of 5 for Subject 2). A representative sample of one of the successful pairing sessions for each subject is presented in Figures 2 and 3. Figure 2 shows that Subject 1 did not emit the targeted phoneme ("da") during the pre-pairing observation, but she did emit one non-targeted phoneme ("ah"). The subject's overall rate of vocalization was .5 responses per minute. During pairing the phoneme "da" was paired with reinforcement (soap bubbles) 24 times in 190 seconds. During the post-pairing observation the targeted phoneme was emitted a total of 15 times in 6 minutes, with an average rate of 2.5 responses per minute. Also, during that time the subject emitted 16 other vocalizations resulting in an overall increase in the subject's rate of vocalization to 5.16 responses per minute. The attempt to pair a novel vocal topography ("ba") with an established form of reinforcement failed to result in the immediate emission of that response during the post-pairing observation.

Figure 3 shows that during the pre-pairing observation Subject 2 did not emit the targeted response, or any other vocal response. The phoneme "ga" was paired with reinforcement (soap bubbles) 15 times in 100 seconds. During the post-pairing observation the targeted phoneme was emitted a total of 59 times in 5 minutes, with an average rate of 11.8 responses per minute. Also, during that time the subject emitted 30 other vocalizations (primarily "ah" and "ma"), resulting in an overall increase in the subject's rate of vocalization to 17.8 responses per minute.

Negative condition. The results from the negative condition show that responding

immediately decreased in all three pairings. In the first session involving the pairing with "Bad girl," responding ceased altogether. In the other two sessions only the targeted vocalization ceased to occur. A representative sample of one of these two sessions is presented in Figure 4. During the pre-pairing observation Subject 1 emitted the targeted response ("da") 41 times in 3 minutes (13.66 responses per minute), and 30 other vocalizations (mostly "ba," "ma," and "ah"). The subject's overall average response rate was 23.66 vocal responses per minute. During pairing the experimenter emitted the phoneme "da" 3 times in 10 seconds, and each time followed it with the sternly spoken words "Bad girl[2]." During the post-pairing observation, the subject was silent for the first minute, but then began to babble again. However, she did not emit the targeted response during post-pairing, and the overall response rate dropped to 3.4 responses per minute. The results of the second pairing ("ma") produced a very similar pattern of behavior during post-pairing.

DISCUSSION

The results of this study support and extend the results of previous research on automatic reinforcement by Sundberg et al. (1996), by showing that a typical infant's rate of vocal play can be increased by pairing specific phonemes with established forms of reinforcement. In addition, the current study also demonstrates the minimal effects of neutral pairing, and the immediate and disruptive effects of pairing adult vocal behavior with aversive stimuli. These data suggest that a critical variable related to an infant's native language acquisition is the stimulus-stimulus pairing process that occurs when parents or caretakers speak to their infants.

[2]It is important to note that this procedure was approved by the University's human rights committee. The fact that the experimenter was the child's father, and that the reprimands were brief resulted in the approval. It should be noted that these data were collected 17 years ago, and it is possible that opinions have since changed. It should also be pointed out that the subject experienced no long-term effects from these procedures.

Perhaps the most significant aspect of these results was the sharp decrease in vocal behavior that occurred in the relatively brief negative condition. The effects of both direct and automatic punishment can be observed in these data. In all three sessions vocal behavior immediately ceased after the pairing, demonstrating the immediate effects of direct punishment (i.e., "Bad girl"). In two of the sessions other vocal responses began to occur again after approximately 1 minute, but the targeted phoneme was not emitted (until well after the session). This selective effect on vocal responding appears to demonstrate the automatic punishment effect.

However, the question of how automatic punishment reduces behavior prior to its overt emission is in need of further analysis. It is possible that because of their frequent co-occurrence, the kinesthetic stimulation caused by the sub-vocal emission of a particular sound becomes equivalent to the auditory stimulation caused by that sound. The pairing of the neutral stimuli with a mild aversive stimulus in the pairing procedure may have had the same effect as if the vocal musculature movement required to produce the sound were directly punished. This equivalency of the kinesthetic and auditory stimulation may have resulted from the pairing procedure, and may explain why the behavior was suppressed at the covert level.

The direct and automatic effects of consequences can also be observed in the other two conditions. The positive pairing condition resulted in an immediate increase in the children's on-going vocal play because this behavior was often (noncontingently) followed by the experimenter's attention, and presentation of reinforcement (e.g., the bubbles). One might expect, then, for the children's overall vocal behavior to increase as a function of this accidental direct reinforcement. The automatic effect on vocal behavior was observed at a later point when a specific phoneme that was not prompted or emitted during pre-pairing, did occur during the post-pairing observation.

A further demonstration of the separate effects of direct and automatic conse-

quences can be observed in the results of the neutral condition. In this condition non-targeted responses increased, but not the targeted response. During the pre-pairing observation this subject had been emitting vocal behavior at a rate of approximately 3 sounds per minute. It is possible that the non-targeted responses increased because one of these responses was accidentally followed by adult attention (the presentation of the unpaired phoneme). The fact that the targeted phoneme was not occurring just prior to the pairing, and that it was not paired with a strong form of reinforcement, was probably responsible for the lack of a direct or an automatic reinforcement effect on that phoneme.

The implications of these results seem substantial. It appears that infant vocal behavior is quite susceptible not only to reinforcement, but also to punishment. Subject 1, the only subject to participate in the negative condition pairing, was under the control of the experimenter since birth. The fact that she was unaccustomed to punishment for vocal responding may account for the robust effects observed in the negative condition. However, some parents and caretakers may not actively pair their vocalizations with reinforcement (the neutral condition), or be unintentionally pairing their vocalizations with aversive stimuli. These two effects could be observed with very young children, and could possibly result in a reduced tendency for infants to babble.

Another interesting aspect of these results is how quickly changes in the frequency of vocal behavior occurred as a function of these briefly manipulated environmental variables. The current study demonstrated how a single sound ("da") can come in and out of an infant's vocal babbling repertoire, simply by being paired with different stimuli (see Figures 1, 2, & 4). These results have implications for the analysis of how humans so readily acquire their native language skills. They also provide a possible explanation as to why some infants and children lose vocal and verbal responses that were once strong in their repertoire. These results also have implications for explanations as to why language might fail to develop for some children, and they can lead to the improvement of techniques for teaching language to individuals who fail to acquire verbal behavior.

The results of the current study show several similarities to the previous research by Sundberg et al. (1996), but they also differed in some important ways. For example, the studies were similar in that the positive pairing produced an increase in vocal behavior, but also on some occasions the pairing was ineffective. The current study does not present any new information as to why pairing is not always successful, but like Sundberg et al. (1996), the current authors speculate that the failure is relevant to the child's current emotional state and competing establishing operations. The current study differs from Sundberg et al. (1996) in that the attempt to obtain a novel response failed. It is possible that in order to generate new behavior with infants more than just a few minutes of pairing is required. In addition, it is possible that since the subjects used by Sundberg et al, (1996) were older, they already possessed a minimal echoic repertoire, and the combination of these minimal units to form novel responses was easier then the complete acquisition of new response forms.

In conclusion, the results of the current study support the assertion of Skinner (1957) and others, that automatic reinforcement and automatic punishment play a significant role in language acquisition. The results also have implications for the analysis of how children readily acquire their native language without the deliberate delivery of observable reinforcement by their parents or caretakers. In addition, these results have implications for the explanation of why a child's language skills might fail to develop in a typical sequence. Finally, it is also possible that automatic consequences are partly responsible for the wide range of individual differences observed in the language abilities of children (Hart & Risley, 1995).

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