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FAMILIARIZATION EFFECTS WITH THE "REINFORCER" STIMULUS
IN CHILDREN'S DISCRETE TRIAL INSTRUMENTAL RESPONDING

by Robert G. Watters, M.A.

Thesis presented to the Faculty of Graduate
Studies of Carleton University in partial
fulfillment of the requirements for the
Ph.D. degree

Ottawa, March, 1973

Robert Gordon Watters

1973

The undersigned recommend to the Faculty
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in partial fulfilment of the requirements for
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May, 1973

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Ottawa, March, 1973.

A number of studies have shown that if children are familiarized to a stimulus by attending to a series of presentations of that stimulus, they will make faster responses in a reaction time task when a non-familiarized (novel) stimulus serves as a signal to respond as compared to when the familiarized stimulus serves as a signal to respond. This phenomenon, referred to as the stimulus familiarization effect (SFE) has been explained by reference to the orienting response (OR). Specifically it has been hypothesized that the familiarization procedure results in the habituation of the OR to the familiarized stimulus (FS). The consequence is a weaker OR following the presentation of the FS as compared to following the presentation of the NS. It is further hypothesized that speed of responding on a reaction time task is positively related to the strength of the OR. Hence the weaker OR following the FS results in slower responding to the FS than to the NS.

If the novel and familiarized stimuli are used in the position of reinforcer in a discrete trial instrumental reaction time task then the OR-habituation hypothesis would lead one to expect that the relatively stronger OR resulting from the presentation of a NS as reinforcer would influence the speed of responding on any immediately following reaction time task. This influence could be measured on a second response device in which case one would expect faster

responding on device 2 following the presentation of the NS as a reinforcer on device 1, as compared to responding after the presentation of the FS as a reinforcer on device 1. If there was no second device but rather a series of responses on one device then the influence would be detected in generally faster speeds for groups receiving some NSs and some FSs as reinforcers as compared to groups receiving only FSs as reinforcers. Two experiments tested these implications of the OR-habituation hypothesis.

During the familiarization phase of both experiments the Ss were repeatedly exposed to a light stimulus (the FS). In the Double Lever Study, following each response on lever 1 a light stimulus was presented, then a response was made on lever 2. A FS followed all control group lever 1 responses. A random sequence of NS and FS followed experimental group lever 1 responses. Start and movement times were measured. Early experimental group lever 2 start speeds were slower following NS than following FS. There were no movement speed differences.

In the Single Lever Study, following each response on a lever pulling device a light stimulus was presented. For one group each stimulus was a FS; for a second group each stimulus was a NS; for a third group stimuli were a random sequence of FS and NS; and for a fourth group stimuli were a random sequence of two NSs. Start and movement times were measured. There was no evidence for differences in start or movement speeds.

There was then no support for the predictions derived from the OR-habituation hypothesis. Suggestions for future research are outlined.

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INTRODUCTION

If children are familiarized to a stimulus by attending to a series of presentations of that stimulus, they will make faster responses in a reaction time task when a non-familiarized (novel) stimulus serves as a signal to respond as compared to when the familiarized stimulus serves as a signal to respond. This phenomenon, referred to as the stimulus familiarization effect (SFE) has been explained by reference to the orienting response (OR). Specifically it has been hypothesized that the familiarization procedure results in the habituation of the OR to the familiarized stimulus. The consequence is a weaker OR following the presentation of the familiarized stimulus as compared to following the presentation of the novel stimulus. This weaker OR following the familiarized stimulus results in slower responding to the familiarized stimulus than to the novel stimulus.

If the novel and familiarized stimuli are used in the position of reinforcing stimulus¹ in a discrete trial instrumental task then the OR-habituation hypothesis would lead one to expect that the OR resulting from the presentation of a novel reinforcing stimulus would influence the response speed

1. It should be emphasized that the terms "reinforcing stimulus," "reinforcer" and "reinforced" are used here and subsequently to refer to the position of the stimulus in the paradigm only. No assumption about the functional role of the stimulus is intended.

of any instrumental response which followed. That is, one would expect a SFE-like effect of faster responding on an instrumental task following the presentation of a novel reinforcing stimulus on the preceding instrumental response as compared to responding following the presentation of a familiarized reinforcing stimulus on the preceding instrumental response. The two studies reported test this implication of the OR-habituation hypothesis.

The discrete trial instrumental task just referred to bears a strong resemblance to procedures used in frustrative nonreward studies with children where the S is induced through experience or instructions to expect reinforcement and not to expect nonreinforcement. Should evidence be found for the SFE-like phenomenon the question would arise as to its role in child frustrative nonreward studies.

In an attempt to test for the effect and to gain some understanding of its role in frustration studies the two basic child frustrative nonreward paradigms, the single lever, and the double lever, were used in the studies reported.

The report will be presented in four chapters. The first chapter reviews the child stimulus familiarization effect studies and discusses the OR-habituation hypothesis. Chapters two and three each report on one study including analysis and results. The final chapter discusses the results of the two studies and suggests directions for future research.

CHAPTER I

REVIEW OF THE LITERATURE

1. The Stimulus Familiarization Effect Studies

In the volume Conflict Arousal and Curiosity (1960, p. 69) D.E. Berlyne noted that "a number of East European studies suggest that stimuli which have lost their novelty have a reduced capacity to function as conditioned stimuli." This statement has generated a series of studies with pre-school to grade one Ss. These studies are focused specifically on the question: If a subject repeatedly attends to a stimulus, what effect will this familiarization experience have upon the S's subsequent performance on an instrumental conditioning task in which that stimulus serves as a signal to respond?

The first study of the series (Cantor & Cantor, 1964) had two parts. In the first part, the familiarization phase, the Ss were instructed to attend to a series of forty, 2 second exposures of a stimulus, each exposure being preceded by a verbal "ready" signal. For one half of the Ss the familiarized stimulus (FS) was a buzzer and for the other half the FS was a white light. The stimulus to which the S was not familiarized was designated the novel stimulus (NS).

In the second part of the experiment, the S was given fifty trials on a lever pulling task. At a verbal "ready"

signal the S placed his hand on a start mark on the table at the base of a lever box. The S had been instructed to reach up quickly and pull the lever at stimulus onset. The stimulus series was a random 50:50 sequence of the FS and NS. During this second part of the experiment, the starting time (time from stimulus onset to the initial movement of the lever away from its resting position) and the movement time (time for the movement of the lever through its entire excursion) were measured. Reciprocal transformations gave starting speeds and movement speeds (this practice is followed throughout the series of studies reviewed). All lever pulls were rewarded with a marble, the marbles being traded in for a toy at the end of the game.

The major finding was what Cantor and Cantor called the stimulus familiarization effect (SFE); faster starting speeds on the trials where the lever was pulled to NS onset as compared to trials where the pull was to FS onset. This superiority of starting speeds to the NS over starting speeds to the FS was maintained across eight blocks of 3 trials. An additional finding was that there was a decrease in starting speeds across trial blocks. There was no evidence for the SFE on the movement speed variable.

Several suggestions were made by way of explanation. One was that perhaps a novel stimulus functions as a more effective stimulus than does a familiar stimulus in children's

instrumental conditioning. An alternative suggestion was that the instructions to attend to the stimulus during the familiarization phase may have resulted in a sustained attending response to the FS, which, in spite of the instructions given to the S during the testing phase, interfered with the prompt starting of the lever pulling response when the FS served as the signal to respond.

Since the findings suggested that the SFE was obtained principally with reference to the buzzer stimulus, in their next study (1965), Cantor and Cantor wished to see if they could demonstrate the SFE working entirely within the visual dimension.

During the familiarization phase forty preschool-age children were instructed to attend to a series of forty, 3 second exposures of a stimulus (a red light for one half the Ss and a green light for the other half of the Ss). During the fifty testing trials the stimulus series was a random 50:50 sequence of the FS and NS. Since the 1964 study displayed the SFE on starting speeds only, this time Cantor and Cantor used a discriminative reaction time task, under the assumption that it would be sensitive to the effect under study. The Ss were required at stimulus onset, to lift their finger as quickly as possible from a neutral position and push down on a red or green button corresponding to the stimulus light colour. The Ss were told that if they were quick

enough they would win a toy at the end of the game.

The results indicated that reaction speeds were significantly slower when the FS served as a signal to respond as compared to when the NS served as a signal to respond; that is, a SFE was demonstrated for the reaction speed measure. This SFE held up across five blocks of 5 trials each. As with the previous study, it was found that speeds decreased over trials.

At the suggestion of R.S. Bogartz, Cantor and Cantor looked at the sequencing in the schedule of stimulus presentations. There were four situations which were possible: FS following FS, NS following FS, FS following NS, and NS following NS. When the mean response speeds to the second stimulus in each of the possible couplets were compared, it was found that the response speed to NS following FS was significantly faster than that to FS following FS. Other comparisons revealed no significant differences. When the data for the 1964 study were looked at using a similar analysis, no sequential effect was obtained.

At this point Cantor and Cantor proposed several explanations of the SFE. The explanation, previously suggested, in terms of the interfering effect of instructions to attend, they felt, was still a possibility. A second suggestion was that familiarization leads to habituation of the attending response to the FS, with a resulting tendency of the S to pay

attention to irrelevant stimuli in the situations. This decrement in the tendency to attend to the FS would then result in a decreased speed of responding to that stimulus in the motor task. It should be noted that these two explanations emphasize the inhibitory effect which the familiarization experience may have had on subsequent responding to the FS. The third possibility they presented was a restatement of a suggestion made at the end of the first study. It was that familiarization procedures had a facilitory influence on responding to the NS. If repeated exposure to one stimulus (the FS), makes the subsequent appearance of a second stimulus a "surprising" event, then they argued, an increased level of generalized drive or perhaps a heightened orienting reaction accompanying the surprise may make the response to the NS more effective than it might otherwise have been.

To account for the sequential effect they speculated that the familiarization training leads the S to expect a FS to be followed by a FS and if instead a NS follows there is possibly, surprise, resulting in faster responding.

Witte (1965) was interested in the effect of exposure duration during familiarization on the magnitude of the resultant SFE. During familiarization the S was presented with forty exposures of either a red or a green light. For one half the Ss, the exposure duration during familiarization was 1.5 seconds and for the other half of the Ss it was 4.5

seconds. The testing phase consisted of forty-eight trials of a lever pulling task similar to that used by Cantor and Cantor (1964). The signal to respond followed a verbal "ready" by 2, 3 or 4 seconds. The sequence of stimuli used was a 50:50 random series of the NS and FS. The results indicated a SFE on the starting speed measure but the magnitude of the SFE did not differ for the 1.5 second and 4.5 second exposure groups. There was no evidence that the SFE dissipated across trials and there was no evidence for a SFE on the movement speed data.

It would seem then, that at least within the time limits investigated in this experiment, the magnitude of the SFE is not affected by the duration of the individual exposures of the FS during familiarization, but is a product of exposure per se.

In a study by Cantor and Cantor (1966), the object was to discover how many exposures of the familiarized stimulus were necessary in order to obtain the SFE. Eighty 4 to 6 year olds were given varying amounts of familiarization training to the FS with a white light used as a filler to round out each training series to forty trials. The familiarization phase took one of two forms. For one group it involved exposure to thirty-five presentations of the FS (a red or green light) and five presentations of the white light. The second group was exposed to five presentations of the FS and thirty-five

presentations of the white light. For one half of the Ss in each group the FS was a red light and for the other half it was a green light. The testing phase was identical to that used by Cantor and Cantor (1965), a discriminative reaction time measure being taken on fifty trials using a random 50:50 sequence of the NS and FS.

The results demonstrated a SFE but there was no significant difference between the group receiving thirty-five familiarization trials and the group receiving 5 familiarization trials. The SFE dissipated over trials, the effect reversing (faster responding to the FS than to the NS) for the last third of the trials. In addition, mean response speeds decreased over trial blocks. There was also a strong sequential effect indicating that for both the NS and FS, speed was faster to the one when the other occurred on the previous trial. That is, speed to a NS following a FS was greater than speed to a NS following a NS and speed to a FS following a NS was greater than speed to a FS following a FS. Cantor and Cantor referred to this as the change effect (CE).

The analysis which revealed this CE was different from that used in the 1965 study. It was an analysis of variance which had as its within-subjects variables (a) NS vs FS, and (b) change (from the previous stimulus) vs no change (from the previous stimulus). The results indicated (a) a main effect for NS vs FS, with speeds to the NS faster than speeds

to the FS, (b) a main effect for change vs no change, with speeds to changed stimuli faster than speeds to unchanged stimuli, and (c) no significant interaction. When a similar analysis was performed on the data from the 1965 study there was a statistically significant main effect for NS vs FS and a significant main effect for change vs no change with no significant interaction. So both the 1965 and 1966 studies display the CE.

The major finding, Cantor and Cantor felt, cast some doubt on the hypothesis that the familiarization experience had a decremental effect on subsequent speeds of responding to the familiar stimulus, as they did not find it reasonable to assume that (a) only five familiarization exposures were sufficient to produce such an effect, and (b) thirty-five exposures were no more effective than 5 in producing the effect. They failed to point out that the same criticisms could be made of the "surprisingness" hypothesis.

For the first time Cantor and Cantor speculated as to the reason for the decrease in performance over trials. They attributed it to a general increase in boredom during the experimental session which produced an increase in inattention on the part of the Ss, and so resulted in slower responding.

They proposed that the SFE and the CE might in fact be two aspects of the same phenomenon; both being due to the effects of novelty. The CE might be due to the novelty of

changing from one stimulus to another from trial to trial within the testing phase and the SFE might be due to the novelty generated by the prior familiarization phase.

Bogartz and Witte (1966) report the results of two studies using kindergarten children as Ss. Experiment I had as its main objective the testing of a linear operator model for habituation-dishabituation in the stimulus familiarization situation. Two methodological innovations were introduced. Cantor and Cantor (1964) and Witte (1965) measured movement and starting times and Cantor and Cantor (1965, 1966) measured two choice discriminative reaction times. Bogartz and Witte felt that under the assumptions of the model they were testing a measure of the latency involved in initiating a motor response should be more sensitive to the familiarization effect than a measure which combines the initiation latency and the execution time. They had the S place his finger on a button at a verbal "ready" signal and on presentation of the signal to respond (NS or FS) remove the finger as quickly as possible. The second innovation resulted from the necessity of having an assessment of responsiveness to the FS during familiarization as part of the test of the habituation-dishabituation model. Bogartz and Witte required that the S make the same response during familiarization training as was required later during testing. In previous studies, the Ss had been required simply

to attend to the stimulus during familiarization. This new procedure had the additional advantage of allowing for a test of the hypothesis that instructions to attend given during familiarization may interfere with subsequent responding to the FS during testing (Cantor & Cantor, 1964). Under the new procedure instructions during the familiarization phase did not differ from those during the test phase, so no SFE would be predicted by this hypothesis.

The two primary findings of this first experiment were, (a) a SFE, and (b) no CE. There was no trials variable in the analysis. The finding of a SFE effectively eliminated the "interference due to instructions to attend" hypothesis and the absence of a CE indicated the inapplicability of the habituation-dishabituation model, since this model implied that a CE would be obtained.

Under the familiarization procedure used, where Ss responded as they would in the testing phase and with the use of a response initiation measure, the exposure duration to the stimulus was exactly equal to the response latency. The mean response latency and therefore the mean exposure duration over the familiarization trials was 0.83 seconds. Thus, the SFE was obtained with exposure durations considerably less than the 1.5 seconds (Witte, 1965), 2 seconds (Cantor & Canter, 1964), 3 seconds (Cantor & Cantor, 1965, 1966) and 4.5 seconds (Witte, 1965), used previously. Bogartz and Witte were

careful to point out that this does not mean that shorter exposures would have been effective in the earlier studies, since in their study, requiring the S to make a response during familiarization probably ensured a degree of attention to the stimuli which would not be obtained if the children were merely told to look at the stimuli while they went on and off.

There was no CE in this study which measured initiation speed for a simple motor response and there was no CE in Cantor and Cantor (1964) or in Witte (1965), both of which measured starting and movement speeds for a lever pulling task. There was however a CE in the two other studies by Cantor and Cantor (1965, 1966) where discriminative reaction time was measured. On the basis of these findings, Bogartz and Witte postulated that the CE is associated specifically with the differential motor response to the two stimuli in a discriminative reaction time task. Since the CE was found in the execution of the differential motor response and not in the initiation measure they suggested that it might be due to a tendency on the part of the S to alternate responses. It was unlikely, they felt, that such a tendency was brought by the S to the experimental situation; so the tendency must be acquired during the experiment. Bogartz and Witte's examination of the sequence of test stimuli used by Cantor and Cantor in their 1965 and 1966 studies revealed that on

approximately 75 percent of the trials, the stimulus presented was opposite to that presented on the previous trial. Since Bogartz (1966) had demonstrated that children in this age group can detect such a sequential tendency, Bogartz and Witte argued that this sequence of test stimuli induced an alternation tendency in the S's responses. If this was true, then on trials which had a different stimulus as signal to respond from that used on the previous trial, the response would be facilitated by the alternation tendency and on trials where the signal to respond was the same as that on the previous trial the alternation tendency would interfere with a prompt response. With an alternating sequence then, speeds would be faster on changed as compared to unchanged trials; that is, there would be a CE.

The second experiment reported by Bogartz and Witte (1966, Experiment II) had two objectives; the first was to test their hypothesis suggesting that the CE is induced in the execution of a differential motor response by the sequential structure of the test stimuli; the second was to determine whether the SFE was located entirely in the time taken to initiate a motor response, or if it was also to be found in the execution component of the motor response. This latter question had not been answered by previous studies as the starting time and reaction time measures used in those studies had not separated the initiation time component

(as defined operationally by Bogartz & Witte, 1966, Experiment I) from the execution time component.

To achieve the first objective two sets of test sequences were employed. The first set consisted of sequences which tended to alternate as did those used by Cantor and Cantor (1965, 1966); it was anticipated that these sequences would produce a replication of the CE in the execution measure. The second set consisted of sequences which tended to repeat. It was anticipated that these sequences would induce a repetition tendency in the S's motor responses and that a reverse CE would be obtained; that is, execution speeds would be faster on unchanged trials as compared to changed trials.

To achieve the second objective a discriminative reaction time measure was taken. It was measured in two parts. At a verbal "ready" signal the S held down a button and on presentation of a light stimulus removed his finger and pushed down a green or red button corresponding to the colour of the light. Time from stimulus onset to finger removal was initiation time and time from finger removal to the depression of the green or red button was execution time. During the twenty trial familiarization phase, Bogartz and Witte reverted to the original SFE paradigm which required the S to watch and not to respond during the presentation of the stimulus.

The results indicated (a) a SFE on the initiation speed measure, (b) a CE on the execution speed measure for the

stimulus series which tended to alternate, and (c) a reverse CE on the execution speed measure for the stimulus series which tended to repeat. There was no analysis of speeds across trial blocks. On the basis of these results, Bogartz and Witte concluded that the SFE had been located unequivocally at the initiation of the response with no evidence for it in the execution measure. The Ss started their response to the NS faster than they did to the FS, but once having started they completed their response just as quickly to the FS as to the NS.

The results clearly indicated that the CE is an artifact of the stimulus sequence and the particular response measure used. It is unfortunate that no analysis of the CE was made across trials. If the Bogartz and Witte hypothesis is correct, a response tendency induced by the structure of the sequence of test stimuli should have resulted in no CE on the initial test trials, with an increase in the magnitude of the CE over trials.

Witte (1967) set out to test the surprisingness hypothesis against the habituation hypothesis. He proposed to expose the Ss to both the NS and the FS during familiarization training, but to make the duration of each exposure of the FS three times as long as that of the NS. With prior exposure to both stimuli, the occurrence of either stimulus during testing could not be surprising; hence there would be no SFE

if the surprisingness hypothesis was valid. On the other hand if the habituation model was valid there would still be a SFE as more habituation would have occurred to the FS because of the longer exposures to the FS.

For the familiarization training the Ss were instructed to watch the light carefully. They were exposed to a series of forty presentations of the NS and FS in a random 50:50 sequence. Each exposure of the FS was of 4.5 seconds duration and each exposure of the NS was of 1.5 seconds duration. The response device used in testing was a single lever similar to that used by Cantor and Cantor (1964). The S was instructed to put his hand on the ready mark at a verbal "ready" signal and to pull the lever quickly as soon as the light came on. The stimulus series was a 50:50 random sequence of the NS and FS. Starting times and movement times were measured.

The results indicated (a) a SFE on the starting speed measure, (b) no CE on either measure, (c) a decrease in starting speeds across trial blocks, and (d) the SFE dissipated across trials, the effect being nonsignificant for the last trial block. Witte claimed that the finding of a SFE effectively eliminated the surprisingness hypothesis. The habituation hypothesis, alone, of the original hypotheses proposed by Cantor and Cantor (1965) remained. The lack of a CE is consistent with Bogartz and Witte's assertion (1966, Experiment I) that the CE would be found only on a task requiring a differential

motor response.

F.D. Miller undertook a study (1969) in which different groups received 0, 1, 10, 20 or 40 familiarization trials to a red or green light. A white light was used as a filler to equate the total number of stimulus exposures given to each group. During familiarization Ss observed but did not respond to the stimulus. In the test phase a discriminative reaction time task, similar to that used by Bogartz and Witte (1966, Experiment II), was employed. Initiation times and execution times were measured. In addition to the usual 50:50 mixture of FS and NS, the two counterbalanced sequences of test stimuli were arranged so that there were equal numbers of change and no change trials involving both the NS and FS.

For initiation speeds the results indicated (a) a decrease in speeds across trial blocks, (b) a comparable and significant SFE for subjects given 20 and 40 familiarization trials, and (c) no SFE for the remaining subjects. There was no indication that the SFE dissipated across trials and there was no indication of a SFE for the execution speeds. For each of the five groups there was a significant CE on the initiation speeds and there was a significant CE on the execution speeds for all but the zero familiarization group.

Failure to find a SFE for the 1 and 10 groups is inconsistent with Cantor and Cantor's (1966) finding that five familiarization trials were sufficient to produce a SFE as

strong as that resulting from thirty-five exposures. The CE finding is consistent with the hypothesis that the CE is due to the novelty inherent in the change from one stimulus to another (Cantor & Cantor, 1966) and is inconsistent with the suggestion that the CE is an artifact resulting from a test sequence with a tendency to alternate in a differential motor response task (Bogartz & Witte, 1966, Experiment I). However it should be noted that the finding of a CE on the initiation speeds for the zero familiarization group might indicate that the Ss came to the experimental situation with a propensity towards an alternation of responses. Along this line of reasoning Witte and Cantor (1967) pointed out that the use of a discrimination reaction time task in which the Ss respond differentially to stimuli, means that stimulus and response factors are confounded. Even if the stimulus sequence employed during testing did not induce an alternation tendency in the children they argued that previously acquired response alternation tendencies might facilitate responding on change trials. As support for this contention they pointed to studies by Jeffrey and Cohen (1965) and Rieber (1966) which found that young children do have a tendency to alternate their responses in a two choice situation.

Witte and Cantor (1967) were interested mainly in a re-examination of the surprisingness hypothesis as an explanation of the SFE (Cantor & Cantor, 1965). They recognized that

the studies done previously had not supported the surprisingness hypothesis but argued that these findings did not preclude the operation of a motivational factor. They pointed out that evidence existed which indicated that heightened motivation could facilitate ongoing activities (Brown, Kalish & Farber, 1951). With human subjects, studies had indicated that the facilitative effect did not occur within one half second of the onset of the motivational producing stimulus (Spence & Runquist, 1958) but did occur within $3\frac{1}{2}$ seconds (Spence & Runquist, 1958; Semler & Pederson, 1968). Previous SFE studies had required a response at stimulus onset and the average latency had been of the order of one second. Witte and Cantor argued that the response was probably completed too quickly to benefit from any motivational increment produced by the onset of the NS. Given time for this motivational element to develop they predicted that the SFE would be demonstrable for the movement or execution measure as well as for the initiation or starting measure rather than for the initiation or starting segment only, as in the earlier studies.

Witte and Cantor exposed the stimuli for four seconds and used stimulus offset as the signal for the S to respond. The apparatus was similar to the one used by Witte (1967); it measured starting time and movement time for a lever pulling response. Familiarization consisted of twenty exposures

to a red or a green stimulus light with the S required to attend only. Testing was to two counterbalanced sequences of thirty-three stimuli similar to those used by Miller (1969). The sequence had a 50:50 ratio of NS to FS, in a more or less random order, with the restriction that there were equal numbers of change and no-change trials involving the NS and FS.

The results indicated (a) a SFE on starting and movement speeds, (b) the magnitude of the SFE did not change significantly across the trial blocks, and (c) no CE. The finding of a SFE on both starting and movement measures offers support for the hypothesis of the operation of a motivational factor. The failure to find a CE is consistent with the findings of other studies, where the S made the same response to both stimuli and is therefore consistent with Bogartz and Witte's contention (1966) that the CE is produced only when the task requires differential responding to the two stimuli.

Witte and Cantor obtained a SFE using stimulus offset as the signal to respond but in previous studies the SFE was obtained using stimulus onset as the signal to respond. In an attempt at a unified explanation of these findings, Witte and Cantor made use of the concept of the orienting response (OR). They hypothesized that the familiarization procedure results in an altered speed of responding to the FS but does not affect responding to the NS. Specifically they suggested

that the FS elicits a weaker OR than does the NS due to the habituation of the OR to the FS during familiarization training. Accompanying this hypothesis is the assumption that response speed in a reaction time task is positively related to strength of the OR.

Witte and Cantor proposed that in the 1967 study the SFE was a product of the habituation of the relatively long latency motivational components of the OR. They assume that these long latency changes were present in the earlier studies which measured response speeds to stimulus onset but that since the motivational changes started at stimulus onset the response measures were taken before the motivational components had time to develop. They suggested that there might be short latency components of the OR such as attentional or associative factors which would lead Ss to start their response faster to the NS, but which would have no differential effect on the completion of the response. It is the habituation of these short latency components of the OR, which would lead to slower response initiation to the FS and therefore would be responsible for the SFE on the response initiation measures in the earlier studies (note that Cantor & Cantor in their 1965 study proposed the habituation of attentional factors as an explanation of the SFE).

Cantor and Fenson (1968) undertook a study to clarify the role of the number of familiarization trials in the SFE

paradigm. It will be remembered that Cantor and Cantor (1966) obtained a SFE of the same magnitude for a group given five familiarization exposures as for a group given 35 familiarization exposures. This finding conflicted with the results of Miller's (1969) study where no SFE was obtained with groups given one and ten familiarization trials but a SFE of equal magnitude was obtained for a group given twenty familiarization exposures and another group given 40 familiarization exposures.

Cantor and Fenson essentially replicated Miller's (1969) procedures. Six groups received 5, 10, 12, 14, 16 or 18 stimulus exposures during familiarization with a white light used as a filler to round out the total number of exposures to 18. The sequences of stimuli used during testing were constructed so as to have a 50:50 ratio of NS to FS in a more or less random order with the restriction that there were equal numbers of change and no change trials involving the NS and involving the FS. Forty-nine test trials were administered with an apparatus similar to that used by Miller (1969).

The results indicated (a) a SFE on the initiation speed measure for the first half of the test trials for the group that received eighteen familiarization exposures but no SFE for the second half of the test trials and no SFE for other groups; (b) both initiation and execution speeds decreased across trial blocks; and (c) a CE for the initiation speed measure and a CE in the case of the familiarized

stimulus but not in the case of the novel stimulus for the execution speeds. The SFE findings are in accord with those of Miller (1969) and the investigators concluded that the SFE obtained with only five familiarization exposures (Cantor & Cantor, 1966) is probably not a replicable finding.

The conclusion that the finding of the Cantor and Cantor study (1966) is probably not replicable removes an obstacle that was in the way of acceptance of the habituation hypothesis (Cantor & Cantor, 1965; Witte & Cantor, 1967). It will be recalled that Cantor and Cantor had felt that the findings of their 1966 study cast some doubt on hypotheses which proposed that the familiarization experience had a decremental effect on subsequent speeds of responding to the FS (the habituation hypothesis and the interference due to the instructions to attend hypotheses fall into this category). Their argument was that if these hypotheses were valid it was not reasonable to assume (a) that only five familiarization exposures were sufficient to produce the SFE, and (b) that thirty-five exposures were no more effective than 5 exposures in producing the effect.

Cantor and Fenson's CE findings replicate Miller's (1969) results where a CE was obtained on both initiation and execution measures using a similarly constructed sequence. Cantor (1968) pointed out that this probably invalidates Bogartz and Witte's conclusion (1966) that the CE is

unequivocally located in the execution component of the motor response. Cantor further suggested that the findings of a CE with stimulus series constructed so as not to induce any alternation tendencies might be due to the fact that in both cases (Miller, 1969; Cantor & Fenson, 1968) the series, although having equal numbers of change and no change trials involving the NS and the FS, did have a predominance of short runs, perhaps leading the S to expect stimulus change.

Miller and Moffat (1968) set out to test an implication of Witte and Cantor's (1967) explanation of the SFE as being due to the habituation of components of the OR during familiarization. Concerning the phenomenon of habituation, Thompson and Spencer (1966) state that for most types of responses the weaker the stimulus, the more rapid and/or more pronounced is the habituation, whereas intense stimuli may yield no significant habituation. Miller and Moffat specifically set out to test this assertion using the usual SFE procedures. They assigned the four year old Ss to one of 3 groups where the groups were defined by the intensity of the stimuli used. The high intensity group used red and green lights of 17.00 foot-candles intensity; the medium intensity group used stimuli of 3.08 foot-candles intensity; and the low intensity group used stimuli of 1.60 foot-candles intensity. The Ss were given 71 trials on a simple reaction time task which required that they move their finger from a start position

and push down a button at stimulus onset. On the first thirty trials the familiarization stimulus alone was presented and for the remaining 41 trials the Ss responded on each trial to the onset of either the FS or NS, the stimulus sequence being a random 50:50 sequence of NS and FS. Response times were measured. The results indicated (a) a SFE, (b) a decrease in response speeds across trial blocks, (c) no CE, and (d) no evidence that stimulus intensity was an affective variable. The finding of a SFE is consistent with earlier studies. The finding of no CE is consistent with earlier studies employing a simple reaction time task, where CE is not found. Miller and Moffat suggested that the lack of evidence for the effect of the intensity variable may be due to the rather limited range of intensities employed. They did not see this lack of evidence as a severe blow to the OR-habituation hypothesis.

Witte (1968) had 64 kindergarten children observe a coloured light for four seconds on each of 20 trials. He then had them perform a discriminative lever pulling task. The FS and NS each served on one half of the 40 trials as a ready signal for a buzzer to which the S responded by removing his finger from a start button and pulling a lever corresponding to the colour of the stimulus. For one half of the Ss the ready signal sequence tended to alternate (TA group) and for the other half of the Ss the sequence tended to repeat (TR group). Reaction time, travel time and movement time were recorded.

Witte speculated, in keeping with the OR-habituation hypothesis that the presentation of either ready signal would produce a mild motivational reaction in S and that this reaction would energize the following response. As habituation of the reaction had occurred to the FS during familiarization, the reaction following NS was expected to be stronger. Consequently, the SFE, that is, faster responding to the NS-buzzer than to the FS-buzzer, was predicted. The results did not support this prediction; there was no evidence for a superiority of NS-buzzer speeds over FS-buzzer speeds.

With respect to the CE, the findings were that for travel speeds there was a reverse CE for the TR group and no CE for the TA group.

There have been two investigations, Watters (1969) and Kubose (1970) which have looked at the SFE as a function of the similarity of the NS to the FS.

In addition to investigating the factor of NS similarity to the FS, Watters (1969) was interested in whether or not the SFE could be demonstrated using stimuli other than the red and green lights and buzzer used in the studies to that point. The study employed stimuli from along a visual spatial dimension on an apparatus similar to that developed by Brown, Bilodeau and Baron (1951) for studies of stimulus generalization. Forty-eight Ss were assigned to one of 3 groups. Each subject was exposed to twenty presentations of a 5 second

stimulus light during a familiarization phase. They were then given thirty-three reaction time trials for which the signal to respond was either the NS or FS in a 50:50 random sequence of the NS and FS. For group N1 the NS stimulus light was 3 positions away from the FS light along the linear visual spatial array of lights; for group N2 the NS was 6 positions away from the FS and for group N3 the NS was 9 positions away. Initiation and execution times were recorded.

The results showed no evidence for differences in the initiation or execution speeds between the three groups. There was some evidence for an overall SFE on the initial trials of the initiation speed measure. With respect to the CE the finding was of a reverse CE on initiation and execution speeds; that is, speeds were faster on trials where the stimulus to respond was unchanged from that of previous trials as compared to trials where the stimulus was changed. This CE, it was pointed out, was quite unlike that found in previous studies in that (a) previous studies found faster speeds of responding to the changed stimuli with the one exception of Bogartz and Witte (1966, Experiment II) where the object was to induce a reverse CE; (b) the task was not a discriminative reaction time task as were those in the previous studies finding the CE (Cantor & Cantor, 1965, 1966; Bogartz & Witte, 1966, Experiment II; Miller, 1969; Cantor & Fenson, 1968; Witte, 1968) and without which the CE had not previously been obtained; and

(c) the study used a neutral stimulus series designed by Miller (1969) to induce neither a CE nor a reverse CE.

It was suggested that this CE might be due to a peculiarity of the visual spatial array of stimuli which required the S to reorient to each change in stimulus position, and so respond slower to changed stimuli.

Kubose (1970) investigated the SFE as a function of the similarity of the NS to the FS using stimuli varying along a hue dimension (red, orange, yellow and green lights). Each of the first grade Ss was familiarized to one of the stimulus colours. Following familiarization the Ss responded in a button pressing task to the FS and to the three remaining novel stimulus colours (NS1, NS2, NS3) mixed in a random sequence. Start and travel times were measured.

A mixed design analysis of variance was conducted on the start speeds and on the travel speeds. The within-subject variables were (a) stimulus type (FS vs NS1 vs NS2 vs NS3), and (b) trial blocks. The between-subject variable was counterbalancing condition (red as the FS vs green as the FS).

For the start speeds there was no significant main effect for stimulus type, however, a preplanned comparison of start speeds to NS3 vs start speeds to FS was significant with faster speeds to NS3. There were no significant effects for travel speeds.

When similar analyses of variance were conducted on

on the latencies, there was for start latencies a significant main effect for stimulus type with the NS3 latency shorter than the FS latency and with the NS3 latency shorter than the NS2 latency.

2. Summary of the Results of the SFE Studies

Related to the SFE, the results of this series of stimulus familiarization studies with children can be summarized as follows: (a) the SFE has been demonstrated reliably, using red and green lights as stimuli; (b) the SFE is usually found on the starting or initiation portion of the motor response, the exception being Witte and Cantor's study (1967) which used stimulus offset as the signal to respond; (c) the SFE has been demonstrated for both simple and differential motor responses; (d) the speed of responding seems to decrease across trial blocks of the testing task; and (e) the most viable hypothesis explaining the SFE seems to be that originally proposed by Cantor and Cantor (1965) and expanded by Witte and Cantor (1967), which suggested that the SFE is due to the habituation during training of various components of the orienting response to the FS.

Related to the CE the results of the series of stimulus familiarization studies with children are: (a) the CE occurs only when the S is required to make a discriminative motor response (the CE obtained by Watters, 1969, can probably be dismissed as a peculiarity of the visual spatial dimension

employed); (b) the locus of the CE is as yet undefined, it having been found on the response speed measure in two studies (Cantor & Cantor, 1965, 1966) which did not partition the response into two components, on the initiation and execution speed measures for two studies (Miller, 1969; Cantor & Fenson, 1968) which partitioned the response into components, and on the execution speed measure, only, in another two studies (Bogartz & Witte, 1966, Experiment II; Witte, 1968) where the response was partitioned; and (c) the most viable hypothesis explaining the CE is that suggested by Bogartz and Witte (1966) which postulates that the CE results from tendencies to alternate responses, induced in the S by the test sequence or brought by the S to the experimental situation.

3. An Implication of the OR-Habituation Hypothesis

From this point on the focus of the discussion will be on the SFE. From the foregoing review it appears that the most viable hypothesis explaining this phenomenon is that of the habituation of OR components during familiarization.

In both papers reviewing the stimulus familiarization literature, G.N. Cantor (1969a, 1969b) reaches the same conclusion. The hypothesis is not accepted without misgivings, but the process of elimination leaves the OR-habituation hypothesis as the most tenable of those proposed.

The OR-habituation hypothesis, as it has been developed

to explain the SFE data can be explicitly outlined as follows:

1. Stimuli presented to a S normally elicit an orienting response (OR).
2. The OR is a complex of responses (reflex and operant) including short latency attentional and associative components and longer latency motivational components.
3. With repeated exposure of the stimulus to the S (familiarization) there is a response decrement (habituation) for the OR.
4. Tentatively the parametric characteristics of habituation are taken to be those outlined in the discussion of the concept by Thompson and Spencer (1966).
5. Speed of responding on the kinds of tasks used in the stimulus familiarization effect studies is assumed to be positively related to the strength of the OR.
6. As a consequence of 3. there will be a weaker OR following a familiarized stimulus (FS) as compared to following a nonfamiliarized or novel stimulus (NS).
7. As a consequence of 5. and 6. responding following a familiarized stimulus (FS) will be slower than responding following a nonfamiliarized or novel stimulus (NS).

It should be noted that there is nothing in this explanatory scheme which limits it to a paradigm where the

stimulus serves as a signal to respond. The scheme should be equally applicable to situations in which a response is made relatively soon after a stimulus has been presented to the S (just how soon after would have to be empirically determined).

Accepting the OR-habituation hypothesis leads one to predict some rather interesting results when the NS and FS are moved from the position of signal to respond to the position of reinforcing¹ stimulus in a discrete trial instrumental response paradigm. Imagine a situation where the stimulus presented following an instrumental response was one of 2 stimuli and in which the S had been familiarized, through prior exposure to one of the stimuli (the FS) and not to the other (the NS). In accordance with the OR-habituation hypothesis one would expect a relatively greater OR following the presentation of the NS.

If the situation was such that the S was to make another motor response following the presentation of a reinforcing stimulus and if it is assumed that the S's speed of responding on this motor task is positively related to the strength of the preceding OR, then one would expect relatively faster responding following the delivery of a NS reinforcer as compared to

1. The reader is again reminded that references to "reinforcing stimulus," "reinforcers," etc., imply no assumptions about the functional role of the stimulus. All that is referred to is the position of the stimulus in a paradigm.

following the delivery of a FS reinforcer. This hypothesized effect will be referred to as the reinforcer-SFE to distinguish it from the usual SFE involving stimuli as signals to respond. It is this implication of the OR-habituation hypothesis that is investigated in the two studies reported below.

Should the reinforcer-SFE phenomenon be demonstrated, the finding would serve not only to extend the SFE literature but it would also be of potential relevance to the child frustrative nonreward literature (see Ryan and Watson, 1968, for a review of this literature).

There are two basic paradigms, the double lever, and the single lever, typically employed in the study of frustrative nonreward in children. The double lever procedure involves the use of two lever boxes similar to those described later in the discussion of the single lever study (see page 40). In this procedure a trial constitutes a response on the first lever box followed by a response on the second lever box. In the testing phase there are a series of trials with each response on the first lever box followed by a reinforcement or a nonreinforcement. Responses on the second lever box are always followed by a reinforcement. The widely used reinforcement is a marble and the marbles accumulate, in view of the S, in a goal box on the bottom front of the lever box.

Before the S starts to make this series of instrumental

responses the S expects to be reinforced for each response. This expectancy may be brought by the S to the situation or it may be induced in the S through instructions or through the experience of making a number of responses, each of which is reinforced. After this expectancy has been built up it is found that responses on the second lever box following a non-reinforcement on the first lever box are faster than responses on the second lever box following the delivery of a reinforcement on the first lever box. This effect is known as the frustration effect (FE) and it is hypothesized to be due to "frustration". "Frustration", a motivational construct, is an aversive emotional state contributing to drive level, which is a consequence of nonreinforcement when reinforcement is expected.

The single lever procedure involves the use of one lever box, similar to those used in the double lever paradigm. In this procedure a trial constitutes a response on the lever box. In the testing phase there are a series of responses on the box, each of which is followed by a reinforcement or a nonreinforcement. As in the double lever paradigm marbles are typically used as reinforcers and as in the double lever paradigm, before making the series of instrumental responses the S has an expectancy for reinforcement. With this procedure, any motivational effect following the delivery or nondelivery of a reinforcer is not detected on a second response device,

but rather, influences the following responses on the same lever. The result is that a group receiving some nonreinforced trials (the partial reinforcement group) has, in general, faster response speeds than a group which always receives reinforcement. This generally faster responding of the partial reinforcement group could be due to the perseveration of the drive increment produced on nonreinforced trials or it could be due to an anticipatory form of frustration (See Amsel, 1958, for details of the mechanism involved). In the case of the child frustrative nonreward literature it has not been clearly demonstrated whether one or both of these mechanisms is in operation.

Even though the SFE procedure is quite distinct from the child frustrative nonreward procedures there are some striking similarities in both procedures and in the underlying processes hypothesized to be taking place. For both the SFE and frustration studies in the testing phase a stimulus is presented just before an instrumental response by S on a reaction time task (for the double lever frustration paradigm this preceding stimulus is the reinforcing event on lever box 1, for the single lever frustration paradigm this preceding stimulus is the reinforcing event on the preceding response on the lever, and for the SFE paradigm this preceding stimulus is the signal to make the instrumental response). In all cases this preceding stimulus can be one

of two kinds: in the SFE paradigm it is either a familiarized stimulus (FS) or a novel stimulus (NS); and in the frustrative nonreward paradigms it is either a reinforcement or a non-reinforcement. The similarity of procedure is even greater when one considers the case of the frustrative nonreward procedure where the expectancy for reinforcement is built up through the experience of a number of reinforced trials, for in this case the S is being repeatedly exposed to the reinforcing stimulus, an operation which is similar to the repeated exposure of the S to the FS in the familiarization phase of a SFE study. Further investigation would be necessary to determine in what way it is possible to equate the S's expectancy for reinforcement as brought to the testing situation or as induced through verbal instructions, to a familiarization process. In this connection a study by Yaremko, Glanville and Leckart (1972) is of interest. Here it was found that a group of Ss instructed to imagine the occurrence of a stimulus for ten trials during pretesting showed subsequent habituation of the GSR component of the OR during a series of habituation trials that did not differ significantly from that displayed by Ss who had been exposed to the real stimulus during the ten pretesting trials.

Procedurally, then, it appears that embedded in the frustration paradigms are the major phases of a stimulus familiarization paradigm (familiarization to one of two

stimuli followed by a series of instrumental responses, each response taking place after the presentation of one or the other of these two stimuli).

There is a further similarity between the child frustrative nonreward studies and the SFE studies when one examines the processes hypothesized to be taking place. In the frustrative nonreward studies the pretesting procedure is postulated to build up an expectancy for a certain stimulus event (reinforcement). In testing, the occurrence of the other possible stimulus event (nonreinforcement) violates this expectancy and results in "frustration". "Frustration" is a motivational construct contributing to drive level which energizes any following response and makes it faster (the elaboration of this explanatory scheme to explain the single lever frustrative nonreward results, in terms of an anticipatory form of "frustration", has no parallel in the OR-habituation explanation of the SFE studies).

For the SFE studies the OR-habituation hypothesis postulates that the pretesting procedure results in a decreased OR to the FS. In testing, the occurrence of the other possible stimulus event (the NS) results in a relatively stronger OR. The OR "...consists of a whole constellation of behavioral and physiological processes. Some of these processes could be interpreted as reflecting motivational rather than associative or attentional factors [Witte & Cantor, 1967, p. 378]."

This motivational increment facilitates any following response, making it faster.

Even though the mechanisms just outlined do differ, it should be noted that there are similarities. For both the frustrative nonreward and the stimulus familiarization situations the presentation of "the other stimulus event" is postulated to produce some motivational increment in the S which is presumed to facilitate any following instrumental response.

These similarities in procedure and in postulated mechanisms point to the possibility of an overlay of a stimulus familiarization type of effect (labeled the reinforcer-SFE in the discussion on page 32) to the frustration produced effects hypothesized to occur in the frustrative nonreward paradigms. It was these similarities and the possibility of the overlay which suggested that it might be fruitful to examine the effects of moving the NS and FS of a SFE study from the position of signal to respond to the position of reinforcer in a discrete trial instrumental response paradigm.

A full investigation of the similarities between the SFE and frustrative nonreward paradigms would require an extensive series of studies. It is worth emphasizing that the present studies are not directed primarily at this issue but rather at that of trying to detect the reinforcer-SFE. However, the studies are carried out in such a way that should

the reinforcer-SFE be detected, the first general steps towards clarifying its role in the frustrative nonreward paradigms will also have been taken.

There were then two considerations contributing to the design of the studies reported here. The primary consideration was that of probing the generality of the SFE phenomenon by attempting to detect the hypothesized reinforcer-SFE. A secondary consideration was that of taking the first general steps towards clarifying the role of the phenomenon, should it exist, in child frustrative nonreward studies.

Borrowing from the child frustrative nonreward literature there are the two paradigms, the double lever and the single lever, that should be sensitive to aspects of the hypothesized reinforcer-SFE. The advantage of choosing these procedures is twofold. First the lever box response device employed is similar to that used by some of the SFE studies (Cantor & Cantor, 1964; Witte, 1965, 1967; Witte & Cantor, 1967) and is therefore of established efficacy in indexing the SFE phenomenon. Second, should the reinforcer-SFE be demonstrated, the employment of these paradigms decreases the steps that would be necessary to clarify the role of the phenomenon in the typical child frustrative nonreward study.

As previously indicated the double lever paradigm involves the use of two lever boxes similar to those described later in the discussion of the single lever study. In this

procedure a trial constitutes a response on the first lever box followed by a response on the second lever box. Any motivational effect following the delivery (or nondelivery) of the reinforcer for a response on the first lever box is detected in the response speed on the second lever box. A relatively long intertrial interval or an intertrial activity such as blowing bubbles, assembling puzzles or describing pictures is used to give the arousal a chance to dissipate. This is done in the hope that the arousal has decreased sufficiently by the time the next lever box 2 response is made so that a ceiling on response speeds is not reached (if a ceiling is reached then there could be no variation in response speeds on lever box 2 to index variations in arousal level produced by various lever box 1 reinforcement events).

This procedure can equally well be used to index the reinforcer-SFE. Should there be a reinforcer-SFE, it would be demonstrated by faster lever 2 response speeds following the presentation of a NS contingent upon the lever box 1 response as compared to lever 2 response speeds following the presentation of a FS contingent on the lever 1 response.

The single lever paradigm borrowed from the child frustrative nonreward literature involves the use of one lever box, similar to those used in the double lever paradigm. With this procedure, any motivational effect following the delivery or nondelivery of a reinforcer is not detected on a

second response device, but rather, influences the following responses on the same lever. It will be remembered that the result is, in the case of the frustration studies, that a group receiving some nonreinforced trials has, in general, faster response speeds than a group which always receives reinforcement. As indicated previously this generally faster responding of the partial reinforcement group could be due to the perseveration of the arousal produced on nonreinforced trials or it could be due to an anticipatory form of the motivational reaction.

A similar procedure could be used to investigate the hypothesized reinforcer-SFE. Should the phenomenon exist it would be indicated in the single lever paradigm by faster response speeds for a group receiving some trials reinforced with the NS and others reinforced with the FS as compared to a group for which every response is reinforced with a FS.

CHAPTER II

THE SINGLE LEVER STUDY

1. Design

The design (see Figure 1) has ten Ss in each of the 8 Familiarization Level x Reinforcement Condition cells. There were two levels of familiarization; Ss in the High group received thirty-six familiarization exposures to the FS and Ss in the Low group received 20 familiarization exposures to the FS.

There were four Reinforcement Condition groups. Those in the "FS and NS" group had their response followed by the FS on a random half of the test trials and by the NS on the other half of the test trials. Those in the "NS only" group had their response followed by the NS on every test trial. The "FS only" group had their response followed by the FS on every test trial. The "NS and another NS" group had their response followed by the NS on a random half of the test trials and by another NS on the other half of the test trials. For each S there were twenty test trials (not represented in the figure).

		Reinforcement Condition (reinforcement stimuli used during testing)			
		FS & NS	NS only	FS only	NS & another NS
Familiar- ization Level	High	10 <u>S</u> s	10 <u>S</u> s	10 <u>S</u> s	10 <u>S</u> s
	Low	10 <u>S</u> s	10 <u>S</u> s	10 <u>S</u> s	10 <u>S</u> s

Figure 1. Design of the Single Lever Study.

2. Subjects

The Ss were 80 kindergarten children (35 male and 45 female) from the Ottawa Public School system. They ranged in age from 5.0 years to 6.4 years with a mean age of 5.9 years. The data from four additional Ss were rejected as these Ss did not comply with various aspects of the instructions. The Ss were randomly assigned to the eight experimental conditions.

3. Apparatus

The apparatus consisted of one lever box, one control box and one set of stimulus selection and presentation controls, set up in a dimly lit room in a mobile lab parked in the school yard.

The lever box had base dimensions of 12 inches wide by 15 inches deep and was 18 inches high off the table. In side view it formed a right angled triangle with the 12 inch wide by 20 inch face sloping down at approximately a 45 degree angle. There were two hand patterns on the box, a right-hand pattern on the right side of the sloping face toward the bottom, and a left-hand pattern on the left side of the face toward the bottom. In the centre of the face was a $15\frac{1}{2}$ inch vertical channel through which a lever protruded. Adjacent to each side of the channel was a plexiglass window 3 inches wide and 12 inches long through which shone 12 small white bulbs. The bulbs were hidden from view at the periphery but reflected from a

polished aluminum surface behind the plexiglass producing the effect of a light around the lever excursion channel. This light served as the starting signal for a response.

Connected to the box but mounted above and behind it was a vertical panel 7 inches wide by 12 inches high. Behind this panel, and hidden from view by sides which extended back from it, was a Lehigh Valley Electronics multi-stimulus projector (LVE Model 1346) which projected onto a one inch diameter translucent screen mounted with centre 2 inches below the top of the vertical panel. A hood extended out 3 inches toward the S from the sides and top of the panel and served to shield the projection screen from room light and so prevent reflections on the screen.

The box was flat grey in colour and had $\frac{3}{4}$ inch wide black vertical stripes $1\frac{1}{4}$ inches apart on its face with a black hood and black hand patterns.

The box was on a low table, and connected to it by several lengths of electrical wire was a control box mounting two 0.01 second Standard Precision Timers and a start button. This control box along with a rotary stimulus selection switch and a stimulus presentation button was positioned to the side and slightly behind the S where the E could watch the S without protruding directly into the S's field of view. The stimulus presentation button controlled the onset of the reinforcing stimulus; the duration of exposure being deter-

mined by a Lehigh Valley Electronics electromechanical interval timer (LVE model 1309C). The stimulus selection switch determined which reinforcing stimulus was presented when the presentation button was pushed. The choices were between a red, green, blue and white light.

Each trial was initiated by E saying "ready," then 1, 2 or 3 seconds later pressing the start button on the control box. This served to turn on the excursion channel light on the lever box and to start one of the timers. At this signal the S moved his hand from the hand pattern, and pulled the lever. Moving the lever from its resting position closed a microswitch which terminated the first timer and started the second. Near the bottom of the excursion channel the lever closed another microswitch which terminated both the excursion channel light and the second timer. The E then presented the reinforcing stimulus on the lever box projection screen, thus ending the trial.

In the intertrial interval the E recorded the data from the two timers and set the stimulus selection switch for the presentation of the appropriate reinforcing stimulus on the next trial. The rotary selection switch was rotated prior to each trial whether necessary or not, to avoid giving the S cues about the colour of the next reinforcing stimulus light.

4. Procedure

There were three phases to the procedure; (a) familiarization, (b) practice, and (c) testing. The Ss were brought individually to the mobile lab where they were told they would play a game. Their preferred hand was determined by having them draw a circle, then they were given the following instructions:

"For the first part of the game you sit in front of the box and watch up here (E points to the projection screen) while a little light goes on and off a few times. Every time a light comes on you call out what comes on."

The E presented the S with one of two familiarization series of forty exposures. For those in the high familiarization group this consisted of four presentations of the white stimulus light followed by 36 presentations of the FS (either the red or green light depending on random assignment). For those in the low familiarization condition the series consisted of twenty presentations of the white light followed by 20 presentations of the FS. In all cases the exposures were for two seconds. A verbal "ready" preceded each exposure by a randomly determined 1, 2 or 3 seconds. The interval from stimulus onset to the verbal "ready" was four seconds. During the familiarization series, from his position behind and to the side of the S the experimenter was able to observe the S and remind him to attend to the light if he appeared not to

be doing so. For all Ss there was a break of about two and one half minutes duration after 25 presentations. During this break the S played with puzzles, bubble blowing kit or finger puppets that were on a table in a corner of the room. At the end of the forty exposure familiarization sequence the S was given the following instructions:

"Now we're going to play the second part of the game. Here is how you play it. You stand here (E guides S to the front of the lever box) and when I say "ready," put your hand here (put S's preferred hand on the appropriate hand pattern). Then you watch around here (indicate excursion channel light) and as soon as a light comes on, as fast as you can, take this hand (indicate preferred hand), grab hold of this stick (indicate lever) and pull it all the way down here (indicate bottom of excursion channel). If you did it right a little light will come on here (point to the stimulus projection screen). You call out what comes on.

If you make the little light come on enough times you win the game.

Then you wait until I say "ready" again; when I do you put your hand on the box and get ready to play again.

Do you think you know what to do? (If it seems that S is unduly confused the instructions will be repeated).

OK, we'll start to play. You get ready."

The S then went through a series of twenty-four trials; each trial consisting of one response on the lever box. The first four trials were designated practice trials and guidance was given to S as required. The remaining twenty trials were designated test trials. The intertrial interval, the interval between the time point when the response was completed and the reinforcer light came on and the time point when the start

light for the next trial came on was intended to be approximately ten seconds (a sample of these intervals was measured and their mean was 9.3 seconds).

The sequence of reinforcing stimuli differed for each of the four reinforcement conditions. For the "FS and NS" group the first four stimuli were the FS, followed by twenty presentations of the NS and FS in an individually randomized sequence with the restriction that there were two NSs and two FSs in each of the five blocks of 4 trials. For the "NS only" condition the first four stimuli were the FS followed by 20 presentations of the NS. For the "FS only" condition all twenty-four responses were followed by the FS. For the "NS and another NS" condition the first four stimuli were the FS, followed by twenty presentations of the NS and a blue stimulus light in an individually randomized sequence with the restriction that there were two NSs and two blue stimuli in each of the five blocks of 4 trials. All the stimuli were exposed for two seconds.

On each trial two dependent variables were measured and recorded; start time (time from onset of the excursion channel start light to the movement of the lever away from its resting position) and movement time (time from the initial movement of the lever to the completion of the movement at the bottom of the excursion channel).

At the end of the series of trials the S was told he

had done very well and had won the game. He was then brought back to his classroom.

5. Analysis and Results

Data for the first four trials were not analyzed as these trials were considered to be practice trials during which the S was gaining proficiency at making the instrumental response. For the remaining twenty trials reciprocals of the time data were taken to give starting speeds and movement speeds. For each S the starting speeds and movement speeds were separately blocked into five blocks of 4 trials. Then for each S the mean starting speed and mean movement speed, for each block, was calculated.

These block means were then analyzed with a separate Lindquist Type III analysis of variance (Lindquist, 1953) for the starting speeds (see summary, Table I, appendix) and for the movement speeds (see summary, Table II, appendix). For both analyses the between-subject variables were (a) reinforcement condition (four different conditions), and (b) familiarization level (high vs low). The within-subject variable was trial blocks (five blocks of 4 trials).

At the 0.05 α level the only statistically significant effect in the starting speeds was for the trial block variable ($F = 2.852$, $df = 4, 288$). Similarly the only statistically significant effect in the movement speed data at the 0.05 α

level was for the trial block variable ($F = 5.624$, $df = 4, 288$). The mean starting speeds across trial blocks are presented graphically in Figure 2 and mean movement speeds across trial blocks are presented in Figure 3. Differences between the starting speed data points were tested using a Newman-Keuls Test (Kirk, 1968). At the 0.05 α level the mean starting speed on trial block three (1.273) was significantly different from the mean starting speed on trial block five (1.208). All other comparisons were nonsignificant. A similar analysis for the movement speed data points indicated a significant difference between the mean speed on trial block one (2.291) and the mean speeds for each of the other trial blocks (2.470, 2.464, 2.464, 2.429), with no other differences being significant. Although there were no significant trial blocks X reinforcement condition effects, a graph showing starting speeds across trial blocks for each reinforcement condition is to be found in appendix 9. A similar graph for movement speeds is to be found in appendix 10.

Figure 2. Single Lever Study: Starting Speeds Across Trial Blocks.

Figure 3. Single Lever Study: Movement Speeds Across Trial Blocks.

CHAPTER III

THE DOUBLE LEVER STUDY

1. Design

The design (see Figure 4) has twelve Ss in each of four Familiarization Level x Reinforcement Condition cells. There were two levels of familiarization; Ss in the High group received thirty-six familiarization exposures to the FS and Ss in the Low group received 20 familiarization exposures to the FS.

There were two Reinforcement Condition groups. Those in the "NS and FS" group had lever box 1 responses followed by a NS on a random half of the trials and followed by a FS on the remaining trials. Those in the FS group had all lever box 1 responses followed by a FS. For each S there were eight test trials (not represented in the figure).

2. Subjects

The Ss were 48 kindergarten children (25 male and 23 female) from the Ottawa Public School system. They ranged in age from 4.8 years to 6.5 years with a mean age of 5.8 years. The data from seven additional Ss were rejected; one did not want to finish the task; two had to go to the washroom in the middle of the task; and four failed to comply with various aspects of the instructions. The Ss were

		Reinforcement Condition (reinforcement stimuli used during testing)	
		Experimental NS & FS	Control FS
Familiar- ization Level	High	12 <u>Ss</u>	12 <u>Ss</u>
	Low	12 <u>Ss</u>	12 <u>Ss</u>

Figure 4. Design of the Double Lever Study.

randomly assigned to the four experimental conditions.

3. Apparatus

The apparatus consisted of two lever boxes, two control boxes, and one set of stimulus selection and presentation controls in a dimly lit room in a mobile lab in the school yard. The boxes were identical to that described in detail for the single lever study. Both boxes were flat grey in colour. The first box had $\frac{3}{4}$ inch wide black vertical stripes $1\frac{1}{4}$ inches apart on its face, a black hood and black hand patterns whereas the second box was finished similarly but in white. As in the single lever study, the stimulus selection switch determined which reinforcing stimulus was presented when the presentation button was pushed. The choices were between a red, green and white light on lever box 1 and a white letter "O" on a black background for lever box 2.

The boxes were placed side by side on a low table with the front faces angled slightly inward so that a S standing in front of the first box had only to turn slightly and take a small step to be in a position to operate the second lever box.

Each trial required that the S operate lever box 1, then lever box 2. A trial was initiated by the E saying "ready," then a random 1, 2 or 3 seconds later pressing the

start button on the first control box. This served to turn on the excursion channel light on lever box 1 and start one of the timers. At this signal the S moved his hand from the hand pattern and pulled the lever. Moving the lever from its resting position closed a microswitch which terminated the first timer and started the second. Near the bottom of the excursion channel the lever closed another microswitch which terminated both the excursion channel light and the second timer. The E then presented the reinforcing stimulus on the lever box 1 projection screen. Then the S turned to lever box 2, while the E set the stimulus selection switch for the presentation of the "O" on the lever box 2 projection screen.

Except for the omission of the verbal "ready" the same events took place on lever box 2 as took place on lever box 1. The trial ended with the presentation of the "O" reinforcing stimulus on the lever box 2 projection screen.

To the right and behind lever box 2 was a table holding a few puzzles, bubble blowing kit and finger puppets with which the S occupied himself while the E recorded the data from the four timers (two for lever box 1 and 2 for lever box 2) and set the stimulus selection switch for the presentation of the appropriate reinforcing stimulus on lever box 1 on the next trial. The E manipulated the rotary selection switch prior to each trial whether it was necessary or

not to avoid giving the S clues about the colour of the next reinforcing stimulus light.

4. Procedure

There were three phases to the procedure: (a) familiarization, (b) practice, and (c) testing. The Ss were brought individually to the mobile lab where they were told that they would play a game. Their preferred hand was determined by having them draw a circle; then they were given the following instructions:

"For the first part of the game you sit in front of this box and watch up here (E points to lever box 1 projection screen) while a little light goes on and off a few times. Everytime a light comes on you call out what comes on."

The E then presented the S with one of two familiarization series of 40 exposures. For those in the high familiarization group the series consisted of four presentations of the white stimulus light followed by 36 presentations of the FS (either the red or the green light, depending on random assignment). For those in the low familiarization condition, the series consisted of twenty presentations of the white light followed by 20 presentations of the FS. In all cases the exposures were for two seconds. A verbal "ready" preceded each stimulus onset by a randomly determined 1, 2 or 3 seconds. The interval from the onset of the previous stimulus to the verbal "ready" was four seconds. During the familiari-

zation series, from his position behind and to the side of the S the E was able to observe the S and remind him to attend to the light if he appeared not to be doing so.

For all Ss there was a break of two and one half minutes duration after 25 presentations. During this break the S played with the puzzles, bubble blowing kit or finger puppets.

At the end of the forty exposure familiarization sequence, the E gave the S the following instructions:

"Now we're going to play the second part of the game. Here is how you play it. You stand here (E guides S to the front of lever box 1) and when I say "ready" put your hand here (put S's preferred hand on the appropriate hand pattern). Then you watch around here (indicate excursion channel light) and as soon as a light comes on, as fast as you can, take this hand (indicate preferred hand), grab hold of this stick (indicate lever) and pull it all the way down to here (indicate bottom of excursion channel). If you do it right a little light will come on here (point to lever box 1 stimulus projection screen). You call out what comes on. Then you move over to this box (indicate lever box 2) and you do the same thing. You put your hand here (indicate hand pattern on side of S's preferred hand), then watch around here (indicate excursion channel light) and as soon as a light comes on around here (indicate excursion channel) as fast as you can, take this hand (indicate preferred hand), grab this stick (indicate lever) and pull it all the way down to here (indicate bottom of excursion channel). If you do it right a little light will come on here (indicate lever box 2 stimulus projection screen). You call out what comes on.

If you make these little lights come on enough times you win the game (indicate the two reinforcer projection screens).

When you are finished on this box you can play with the things on this table (indicate the puppets,

puzzles, etc.) until I tell you to start on the first box again. While you are playing, I'll be getting the game ready to go again.

Do you think you know what to do? (If it seems that S is unduly confused, the instructions will be gone over again).

OK, we'll start to play then. You get ready on the first box."

The S then went through a series of twelve trials; the first 4 trials were designated practice trials and guidance was given to the S as required. The remaining 8 trials were designated test trials. Each trial consisted of a response on lever box 1 followed by a response on lever box 2. The interresponse interval, the interval between the time point when the response on lever box 1 was completed and the reinforcer light came on and the time point when the start light around the excursion channel on lever box 2 came on was to be kept as short as possible (for a sample of trials this interval was measured and the mean was 5.2 seconds). The inter-trial interval, the interval between the time point when the lever box 2 response was completed and the reinforcer light came on and the time point when the start light on lever box 1 came on was to be about thirty seconds (a sample of these intervals was measured and the mean was 33.3 seconds).

On lever box 1 for Ss in the experimental group ("NS and FS" reinforcement condition) the first four responses were reinforced by 2 second presentations of the FS and the subsequent eight responses were reinforced by 2 second presentations of the FS or NS. This second part of the

sequence was individually randomized for each S with the restrictions that (a) the reinforcement for the first of the eight trials was a NS¹, and (b) there were two NSs and two FSs in each of the first and second blocks of four trials. For Ss in the control group ("FS" reinforcement condition) all lever box 1 responses were reinforced by a 2 second presentation of the FS. The colour of the FS (red or green) was randomly determined for each S.

On lever box 2 for all groups every response was reinforced with a 2 second exposure of the "O" stimulus.

On each trial four dependent variables were measured and recorded; start time (time from onset of the excursion channel start light to movement of the lever away from its resting position) for both boxes and movement time (time from the initial movement of the lever to the completion of the movement at the bottom of the excursion channel) for both boxes. At the end of the test series the S was told he had done very well and had won the game. He was then brought back to the classroom.

1. This practice follows that of Cantor and Cantor (1964, 1965, 1966). Since response speeds tend to be relatively slower on earlier trials in the test series it was anticipated that this procedure would produce an effect opposite in direction to that expected due to the familiarization process.

5. Analysis and Results

Lever Box 1 Data

Data for the first four trials were not analyzed as these were considered to be practice trials during which the S was gaining some proficiency at making the lever pulling response. Reciprocals of the latency measures for the remaining eight trials were taken to produce starting speed and movement speed measures. For each S the starting speeds and movement speeds were separately blocked into two blocks of 4 trials. Then for each S the mean starting speed and mean movement speed for each block was calculated.

These block means were then analyzed with a separate Lindquist Type III analysis of variance (Lindquist, 1953) for starting speeds (see summary, Table III, appendix) and for movement speeds (see summary, Table IV, appendix). For both of these analyses the between-subject variables were (a) reinforcement condition (experimental vs control), and (b) level of familiarization (high vs low). The within-subject variable was trial blocks (first block vs second block).

At the 0.05 α level there were no statistically significant effects for either the starting speed data or for the movement speed data.

Lever Box 2 Data

As indicated previously the first four trials were practice trials and the data from these trials were not analyzed. Reciprocals of the latency data for the remaining eight trials were taken to produce starting speed and movement speed measures. For each S the starting speed data and movement speed data were separately blocked into two blocks of 4 trials. Then for each S the mean starting speed and mean movement speed was calculated for each block and these block means were used in the following analyses of variance.

A separate Lindquist Type III analysis of variance (Lindquist, 1953) was performed on the starting speeds (see summary, Table V, appendix) and on the movement speeds (see summary, Table VI, appendix). For both analyses the between-subject variables were (a) reinforcement condition (experimental vs control), and (b) level of familiarization (high vs low). The within-subject variable was trial blocks (first block vs second block).

There were no statistically significant effects for either the starting speed data or the movement speed data at the 0.5 α level.

The specific focus of interest in the double lever study was the comparison of lever box 2 performance on trials which followed a FS on lever box 1 (FFS trials) as compared to performance on trials which followed a NS on lever box 1 (FNS) trials). Control group data were dropped and a pre-planned analysis of the experimental group lever box 2 data was performed. The mean lever box 2 starting speed on FFS

trials was calculated for the first block and for the second block. The mean lever box 2 movement speed on FFS trials was also calculated for the first block and for the second block. Similar block means were calculated for lever box 2 starting speeds and movement speeds on FNS trials. These means were used in a Lindquist Type VI analysis of variance (Lindquist, 1953) to examine the difference between lever box 2 speeds on FNS and FFS trials.

A separate analysis was run on the starting speed data (see summary, Table VII, appendix) and on the movement speed data (see summary, Table VIII, appendix). The between-subject variable for these analyses was level of familiarization (high vs low). The within-subject variables were (a) type of trial (FNS vs FFS), and (b) trial blocks (first block vs second block). At an α level of 0.05 the only statistically significant effect in these two analyses was a trial blocks X type of trial interaction ($F = 5.455$, $df = 1,22$) for the starting speed data.

This interaction is presented graphically in Figure 5. For comparison purposes the mean starting speeds for the control group are also indicated. The differences between the four experimental group data points were tested at an α level of 0.05 with a Newman-Keuls Test (Kirk, 1968). The difference between the mean speed on the FFS trials in the first trial block (1.190) and the mean speed on the FNS trials in the first trial block (1.083) was significant.

Figure 5. Double Lever Study, Experimental Group: Lever Box 2:
Starting Speeds: Trial Blocks x Type of Trial Interaction.

Also the difference between the mean speed on the FNS trials in the first trial block (1.083) and the mean speed on the FNS trials in the second trial block (1.164) was statistically significant. Other comparisons were not significant.

The interaction indicates then, slower starting speeds on FNS trials ($\bar{X} = 1.083$) than FFS trials ($\bar{X} = 1.190$) for trial block 1 and no statistically significant difference in the starting speeds on trial block 2 ($\bar{X}(\text{FNS}) = 1.164$, $\bar{X}(\text{FFS}) = 1.151$).

A sign test (Siegel, 1956) was performed on the first trial block data comparing each S's mean FNS starting speed with his mean FFS starting speed. At an α level of 0.05 the analysis indicated that a significant number (17) of the total number of subjects (24) showed lower speeds on FNS as compared to FFS trials.

For all experimental Ss, after the first four practice trials, the test sequence of reinforcing stimuli on lever box 1, started with a NS stimulus. This means that the first test trial on lever box 2 was for all experimental subjects, a FNS trial. Consequently, FNS trials occupied relatively earlier positions in the sequence of test trials than did FFS trials. As lever box 2 start speeds tend to increase over the first few trials (see Figure 6) it is possible that the slower FNS starting speeds for trial block 1 on lever box 2 reflect this tendency rather than any characteristics of FNS trials per se.

Figure 6. Double Lever Study: Lever Box 2: Starting Speeds.

To check out this possibility, the first FNS trial (test trial number one for all experimental Ss) was replaced by a FNS trial from further back in the series. This gave a mean FNS trial starting speed for block 1 based upon the second and third FNS trials in the series rather than upon the first and second FNS trials as was the case in the previous analysis. Hence FFS trials were biased in favour of earlier trials as compared to the previous analysis where FNS trials were biased in favour of earlier trials.

A two-tailed t test with an α level of 0.05 was used to compare the new block 1 mean FNS starting speeds with the block 1 mean FFS starting speeds. The test indicated a statistically significant difference in these starting speeds (t = 3.49, df = 23) with the mean starting speed on FNS trials (1.087) slower than the starting speed on FFS trials (1.190).

As with the earlier FNS vs FFS comparison, a sign test (Siegel, 1956) was performed on the data, comparing each S's mean FNS starting speed with his FFS starting speed. At an α level of 0.05 the analysis indicated that a statistically significant number (17) of the total number of subjects (24) showed slower speeds on FNS as compared to FFS trials.

There is then, no evidence that the slower starting speeds on FNS trials is due to the relatively earlier position of FNS trials in the stimulus sequence.

CHAPTER IV

DISCUSSION OF RESULTS

As previously indicated there were two considerations contributing to the design of the single and double lever studies. The primary consideration was that of assessing the generality of the SFE by attempting to detect the hypothesized reinforcer-SFE. A secondary consideration was that of taking the first general steps toward clarifying the role of this phenomenon, should it exist, in the child frustrative non-reward paradigm.

With reference to the first of these considerations, there is no evidence of the reinforcer-SFE. Not only is there no evidence of the reinforcer-SFE but the finding of slower starting speeds on the FNS trials of trial block one for lever box 2 of the double lever study is opposite to the faster responding on FNS trials that the OR-habituation hypothesis would predict.

With reference to the second consideration entering into the design of the studies, there was no evidence of a reinforcer-SFE in the two basic child frustrative nonreward paradigms. Instead of the reinforcer-SFE there is the new finding of slower responding on earlier FNS trials in the double lever paradigm, to be clarified.

It follows from the results of the single lever and

double lever studies that there are two areas for further investigation; one is that of the finding uncovered by the double lever study of slower responding on FNS trials; and the other is that of the SFE itself with particular emphasis on the apparent failure of the OR-habituation hypothesis. Consideration will be given first to the double lever finding.

Regarding the double lever study finding of slower responding on early FNS trials the position taken is that on the basis of this single study it is difficult to make any statement about what mechanisms are at work. If one is interested in following up the finding, then more information is necessary. One approach to further investigation would involve a replication study as its first step. Although what essentially is a replication of the double lever study is proposed, the opportunity would be taken to refine procedures and to gain additional information. Reaction time should be divided into three components by adding a measure of the interval from the onset of the slot light (signal to respond) to the removal of the S's hand from the hand pattern. The ready signal would be automated (although remaining verbal), and all intertrial intervals and interresponse intervals would be automatically recorded. The last change would involve some post-test verbal probing of the Ss in an attempt to determine their understanding of the conditions that must be satisfied in order to produce a reinforcing stimulus.

Should the replication study fail to produce results similar to the double lever study then this line of investigation would be dropped. On the other hand should the replication study again produce evidence indicating slower responding on lever box 2 FNS trials as compared to FFS trials then further investigation of the finding would be undertaken. The investigation would be guided by three questions: (a) what are the parametric characteristics of this new effect, (b) what relation has the effect to the stimulus familiarization effect, and (c) what relation has the effect to the child frustrative nonreward paradigm?

Now we turn to a consideration of the second area for further investigation, that of the SFE in the light of the results of the single and double lever studies.

With the single and double lever studies included there have been six studies (Miller & Moffat, 1968; Witte, 1968; Watters, 1969; Kubose, 1970; the present single lever study; and the present double lever study) which have tested implications of the OR-habituation hypothesis. Of the six studies, only one, Kubose (1970), has indicated even partial support for the hypothesis. A brief review of these studies follows.

Miller and Moffat (1968) focused on one of the parameters of habituation discussed by Thompson and Spencer (1966). Thompson and Spencer stated that for most types of responses

the weaker the stimulus the more rapid and/or pronounced is habituation as compared to strong stimuli which may yield no significant habituation. Using SFE procedures there should be then a larger SFE when a weak stimulus is used for the FS as compared to when a strong stimulus is used for the FS. Miller and Moffat tested for this effect with three groups, each having a different intensity of FS. Although they found an overall SFE, there was no evidence that stimulus intensity was an effective variable.

Most of the SFE studies carry out familiarization with the stimulus that is to serve as the signal to respond. In the testing situation this signal to respond is preceded by a verbal "ready" signal from the E. Witte (1968) changed this procedure. The Ss were familiarized to a visual stimulus which was used in the testing situation as a ready signal for a buzzer signal to respond. The OR-habituation hypothesis would predict a stronger OR following a novel ready signal as compared to following a familiarized ready signal and consequently greater speed following the novel ready signal-buzzer combination than following the familiarized ready signal-buzzer combination. The results did not support this prediction.

Thompson and Spencer (1966) state that habituation of a response to a given stimulus exhibits stimulus generalization to other stimuli. This implies a gradient of amount of habituation with the maximum habituation to the FS and

decreasing habituation to stimuli that are increasingly dissimilar to the FS. The OR-habituation hypothesis would then predict that the superiority of speeds to the NS over speeds to the FS (i.e., the SFE) would be greater for NSs that are very unlike the FS than for NSs that are similar to the FS.

Watters (1969) looked at the SFE as a function of the similarity of the NS to the FS using stimuli from a visual spatial dimension. Three groups had the same FS but each had a NS with a different degree of similarity to the FS. The results indicated no differences in speeds to the NS between the three groups; that is, there was no evidence for the generalization predicted by the OR-habituation hypothesis.

A second investigation of the SFE as a function of the similarity of the NS to the FS was carried out by Kubose (1970) using stimuli from along a hue dimension. A within-subject design was used with each S being familiarized to one hue and having three other different novel stimuli (NS1, NS2, NS3) presented along with the FS in random order during testing. For start speeds there was no significant effect for stimulus type but a preplanned comparison of speeds to the FS and the most extreme novel stimulus (NS3) was significant with faster speeds to NS3. A post-hoc analysis of start latencies indicated a significant main effect for stimulus type with the NS3 latency shorter than the FS latency and with the NS3 latency shorter than the NS2 latency. This study offered then some

minimal evidence for generalization and so some support for the OR-habituation hypothesis.

The single lever study and the double lever study reported here, offer, of course, no support for the OR-habituation hypothesis.

To repeat then, we have six studies which have tested implications of the OR-habituation hypothesis, with only one offering even partial support for the hypothesis. Since, to be of much value, a hypothesis must have some predictive power, the results of these studies must be regarded as a severe blow to the OR-habituation hypothesis.

In addition to OR-habituation there have been a number of other hypotheses proposed to explain the findings of the SFE studies, but each in turn has run into difficulty.

Cantor and Cantor (1964) suggested that "there is the possibility that the instructions to attend to the stimulus during the familiarization phase may have resulted in sustained attending responses which (...) in the lever pressing phase, interfered with prompt starting [p. 78]." Evidence inconsistent with this sustained attending response hypothesis is to be found in the first study by Bogartz and Witte (1966, Experiment I). Here the Ss were not given the usual instructions to attend during familiarization while a light went on and off. Rather, they were required to make the motor response in both the familiarization and the testing phases of the study. With

such an arrangement one would not expect competing attending responses to build up during familiarization, yet the results indicated the usual SFE.

When faced with the results of Witte and Cantor's study (1967) the sustained attending response hypothesis again does not fare well. In that study a SFE was obtained. The Ss responded in the testing situation to stimulus offset rather than to stimulus onset as in the bulk of the SFE studies. Familiarization procedures were standard, consisting of the S watching while a light came on and went off a few times. As Cantor (1969b) pointed out "it is difficult to see how prolonged attending responses, assuming they were developed in the familiarization phase, could have had an interfering effect at the time of offset on a given motor task trial [p. 155]."

A second hypothesis, proposed by Cantor and Cantor (1965), is that the nonfamiliarized or novel stimulus is surprising. The surprise caused by the appearance of the novel stimulus is hypothesized to result in a heightened state of arousal or drive which in turn leads to faster response speeds to the NS. The surprisingness hypothesis runs into trouble on three counts. First, it is hard to accept that the NS is surprising at the beginning of the testing and continues to be so over the thirty-three (Witte & Cantor, 1967) to 50 (Cantor & Cantor, 1964, 1965) trials of the testing phase. In addition, Witte (1967) is a second source of evidence which is not consistent

with the surprisingness hypothesis. The Ss were exposed to both the FS and the NS during familiarization. With such a familiarization procedure one can hardly argue that the NS was a surprising event to the S in the testing phase. Even so the results of the study indicated a SFE. Thirdly, surprise is taken to be a motivational construct and as such should influence all components of a motor response. However, with the exception of the study by Witte and Cantor (1967) where response was to stimulus offset, the SFE has been found only on initiation or start components of the motor response. There is no evidence for the SFE on the execution or movement components of the response as the surprisingness hypothesis would predict.

A third hypothesis was proposed by Bogartz and Witte (1966). They examined a linear operator model for habituation and dishabituation which they felt might predict the SFE and the CE. The results of the study did not provide evidence for a CE as predicted by the model and so the model was rejected.

Cantor and Cantor (1965) enunciated a fourth hypothesis. This hypothesis proposed that familiarization leads to the habituation of attending responses to the familiarized stimulus with a resulting tendency for the S to pay attention to irrelevant stimuli in the situation. Thus, it was proposed that the familiarization procedure produces a decrement in the tendency to attend to the familiarized stimulus, the result

being a decreased speed of responding to the familiarized stimulus on the motor task in the testing phase. This habituation of attending responses hypothesis was later (Witte & Cantor, 1967) subsumed under the OR-habituation hypothesis. It will be remembered that in proposing the OR-habituation hypothesis Witte and Cantor made reference to short latency attentional and associative components of the OR (thus incorporating the habituation of attending responses hypothesis), as well as to long latency motivational components.

So we arrive at the OR-habituation hypothesis (Witte & Cantor, 1967), the last hypothesis proposed to explain the SFE. It accounts for the results of most of the SFE studies (Bogartz & Witte, 1966, Experiment I, 1966, Experiment II; Cantor & Cantor, 1964, 1965, 1966; Cantor & Fenson, 1968; Miller, 1969; Witte, 1965, 1967; Witte & Cantor, 1967; and perhaps even Kubose, 1970) but it fails to predict the results of Miller and Moffat (1968), Watters (1969), Witte (1968, and the single and the double lever studies reported here.

It can be seen then that all of the hypotheses proposed to explain the SFE have failed at some point. As there are no obvious alternative contenders it would seem that further empirical mapping is indicated. There are many alternative plans for such mapping. What is proposed here is to focus on the difference between the studies which are accounted for by the OR-habituation hypothesis and those which the hypothesis

fails to predict. These latter five studies introduce the most radical variations in paradigm and since it is at this point that the most viable hypothesis (OR-habituation) fails it might be worth examining these variations in detail.

Excluding the first study (Cantor & Cantor, 1964) all of the SFE studies have used lights as the NS and FS, yet with one exception (Miller & Moffat, 1969) they fail to report the intensity of lights used. There is evidence that the magnitude of the OR varies with the intensity of the visual stimulus (e.g., Barry & Beh, 1972). It would seem reasonable therefore, to systematically vary the intensity of the visual stimuli used, over a wide range, and measure the effect on the SFE. It might well be, as Miller and Moffat (1969) have suggested, that the range of intensities used in their study was too restrictive, resulting in the failure to find evidence for stimulus intensity as an effective variable.

Witte (1968) and the present single and double lever studies failed to find the SFE. In each case there is a significant stimulus intervening between the FS or NS, and the motor response used to index the SFE. In Witte's study the buzzer signal to respond intervened between the light ready signal (which was a NS or FS) and the lever pulling response. In the single lever study the slot ready light intervened between the reinforcing event for the previous response (which was a NS or FS) and the current lever pulling response. In the double

lever study the slot ready light on lever box 2 intervened between the reinforcing event on lever box 1 (a NS or FS) and the lever box 2 response. The presence of an intervening stimulus in these studies is in contrast to the absence of such a stimulus in the bulk of the SFE studies where responding is to stimulus (FS or NS) onset or offset. The failure to find the SFE once this variation is introduced suggests that a fruitful line of investigation might be to measure the effect on the SFE, of the introduction of stimuli of varying characteristics into the interval between NS (or FS) presentation and response initiation. Relating to such an undertaking is the literature on the effect of various characteristics of warning or ready signals on reaction time latencies (e.g., duration and intensity of warning signal, Doumas, 1970; intensity, Kohfeld, 1969; intersensory differences, Davis & Green, 1969).

Two studies, Watters (1969) and Kubose (1970) looked for generalization; that is, they looked for an increase in the magnitude of the SFE as a function of the increasing dissimilarity of the NS to the FS. Unlike most SFE studies which used stimuli differing in hue (red and green lights) Watters used stimuli from a visual spatial dimension. This choice was probably unfortunate as the reorientation of the head to a stimulus might well be confounded with the degree of dissimilarity between the NS and FS. This line of investigation should

probably not be followed up at this time. Kubose (1970) on the other hand, using stimuli differing in hue found some weak evidence for generalization. Kubose's findings would seem to justify a replication study. However, a between-subject design probably should be employed as it is possible that his exposure of the Ss to several novel stimuli has an unknown influence on response latencies.

For most SFE studies the indexing motor response is made to stimulus onset. Witte and Cantor (1967), however, used response to the offset of a four second stimulus but still found the SFE. In the present single lever study the indexing response was initiated 9.3 seconds after stimulus onset and there was no evidence of the SFE. In the double lever study the indexing response was 5.2 seconds after stimulus onset and again there was no SFE. It would seem from this evidence that a systematic investigation of variations in the interval between signal onset (FS or NS) and response initiation is in order.

A final suggestion is a reiteration of one made by Cantor (1969a), that there be a series of studies where the S is administered the SFE paradigm and measures are taken of the various components of the OR.

To sum up the discussion, the single and double lever studies present a new finding of slower lever 2 FNS speeds on early trials and no evidence for the reinforcer-SFE.

The response to the new finding is to re-examine its validity with a replication study and then to sketch out its parametric characteristics. Ultimately its relation to the SFE paradigm and the child frustrative nonreward paradigm should be investigated.

The response to the absence of evidence for the predicted reinforcer-SFE is to re-examine, experimentally, the variables manipulated in the last five studies which have failed to support the OR-habituation hypothesis.

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APPENDIX 1

Single Lever Study: Starting Speeds: Type III ANOVA

Source	DF	Sum of Squares	Mean Squares	F-Ratios	Probability
Between-Subject	79.	29.200	.370		
Rows (Familiarization Level)	1.	.594	.594	1.569	.2225
Slices (Reinforcement Condition)	3.	.029	.010	.025	.9750
R x S	3.	1.314	.438	1.156	.3390
Error(B)	72.	27.264	.379		
Within-Subject	320.	5.325	.017		
Columns (Trial Blocks)	4.	.177	.044	2.852	.0378*
C x R	4.	.082	.021	1.326	.2734
C x S	12.	.287	.024	1.539	.1328
C x R x S	12.	.305	.025	1.636	.1035
Error(W)	288.	4.473	.016		
Total	399.	34.525	.087		

APPENDIX 2

Single Lever Study: Movement Speeds: Type III ANOVA

Source	DF	Sum of Squares	Mean Squares	F-Ratios	Probability
Between-Subject	79.	233.562	2.956		
Rows (Familiarization Level)	1.	.164	.164	.057	.7552
Slices (Reinforcement Condition)	3.	16.078	5.359	1.874	.1614
R x S	3.	11.398	3.799	1.328	.2833
Error(B)	72.	205.922	2.860		
Within-Subject	320.	28.643	.090		
Columns (Trial Blocks)	4.	1.851	.463	5.624	.0014*
C x R	4.	.279	.070	.848	.5109
C x S	12.	1.032	.086	1.045	.4118
C x R x S	12.	1.784	.149	1.807	.0653
Error(W)	288.	23.697	.082		
Total	399.	262.205	.657		

APPENDIX 3

Double Lever Study: Lever Box 1:
Starting Speeds: Type III ANOVA

Source	DF	Sum of Squares	Mean Squares	F-Ratios	Probability
Between-Subject	47.	8.900	.189		
Rows (Familiarization Level)	1.	.036	.036	.181	.6430
Slices (Reinforcement Condition)	1.	.036	.036	.183	.6410
R x S	1.	.097	.097	.487	.5195
Error(B)	44.	8.731	.198		
Within-Subject	48.	.279	.006		
Columns (Trial Blocks)	1.	.003	.003	.461	.5087
C x R	1.	.004	.004	.677	.5880
C x S	1.	.004	.004	.734	.6058
C x R x S	1.	.000	.000	.008	.8416
Error(W)	44.	.268	.006		
Total	95.	9.179	.097		

APPENDIX 4

Double Lever Study: Lever Box 1:
Movement Speeds: Type III ANOVA

Source	DF	Sum of Squares	Mean Squares	F-Ratios	Probability
Between-Subject	47.	69.092	1.470		
Rows (Familiarization Level)	1.	.527	.527	.340	.5467
Slices (Reinforcement Condition)	1.	.001	.001	.001	.8715
R x S	1.	.495	.495	.320	.5572
Error(B)	44.	68.069	1.547		
Within-Subject	48.	4.694	.098		
Columns (Trial Blocks)	1.	.370	.370	4.170	.0611
C x R	1.	.092	.092	1.037	.3160
C x S	1.	.004	.004	.047	.7684
C x R x S	1.	.330	.330	3.723	.0745
Error(W)	44.	3.899	.089		
Total	95.	73.787	.777		

APPENDIX 5

Double Lever Study: Lever Box 2:
Starting Speeds: Type III ANOVA

Source	DF	Sum of Squares	Mean Squares	F-Ratios	Probability
Between-Subject	47.	6.561	.140		
Rows (Familiarization Level)	1.	.004	.004	.027	.8657
Slices (Reinforcement Condition)	1.	.022	.022	.153	.6998
R x S	1.	.067	.067	.453	.5114
Error(B)	44.	6.468	.147		
Within-Subject	48.	.536	.011		
Columns (Trial Blocks)	1.	.004	.004	.349	.5645
C x R	1.	.009	.009	.787	.6166
C x S	1.	.028	.028	2.485	.1183
C x R x S	1.	.001	.001	.078	.7780
Error(W)	44.	.495	.011		
Total	95.	7.097	.075		

APPENDIX 6

Double Lever Study: Lever Box 2:
Movement Speeds: Type III ANOVA

Source	DF	Sum of Squares	Mean Squares	F-Ratios	Probability
Between-Subject	47.	73.144	1.556		
Rows (Familiarization Level)	1.	.578	.578	.355	.5615
Slices (Reinforcement Condition)	1.	.011	.011	.007	.9335
R x S	1.	.825	.825	.506	.5125
Error(B)	44.	71.731	1.630		
Within-Subject	48.	6.193	.129		
Columns (Trial Blocks)	1.	.005	.005	.040	.8368
C x R	1.	.001	.001	.005	.9394
C x S	1.	.203	.203	1.520	.2220
C x R x S	1.	.117	.117	.875	.6428
Error(W)	44.	5.867	.133		
Total	95.	79.337	.835		

APPENDIX 7

Double Lever Study: Lever Box 2:
 Experimental Group: Starting Speeds: Type VI ANOVA

Source	DF	Sum of Squares	Mean Squares	F-Ratios	Probability
Between-Subject	23.	4.002	.174		
Group (Familiarization Level)	1.	.038	.038	.2116	.62351
Error(B)	22.	3.964	.180		
Within-Subject	72.	1.306	.018		
A (Trial Blocks)	1.	.011	.011	.5390	.53623
A x G	1.	.015	.015	.7604	.60904
B (FNS vs FFS)	1.	.053	.053	3.3539	.09610
B x G	1.	.001	.001	.0469	.76970
A x B	1.	.086	.086	5.4552	.04186*
A x B x G	1.	.000	.000		
Error(W)	66.	1.140	.017		
Error1(W)	22.	.445	.020		
Error2(W)	22.	.348	.016		
Error3(W)	22.	.347	.016		
Total	95.	5.308	.056		

APPENDIX 8

Double Lever Study: Lever Box 2:
 Experimental Group: Movement Speeds: Type VI ANOVA

Source	DF	Sum of Squares	Mean Squares	F-Ratios	Probability
Between-Subject	23.	93.964	4.085		
Group (Familiarization Level)	1.	2.789	2.789	.6729	.57401
Error(B)	22.	91.175	4.144		
Within-Subject	72.	7.973	.111		
A (Trial Blocks)	1.	.142	.142	.6647	.57111
A x G	1.	.136	.136	.6334	.55980
B (FNS vs FFS)	1.	.000	.000	.0099	.91866
B x G	1.	.007	.007	.1680	.68820
A x B	1.	.175	.175	2.0996	.15832
A x B x G	1.	.022	.022		
Error(W)	66.	7.490	.113		
Error1(W)	22.	4.710	.214		
Error2(W)	22.	.949	.043		
Error3(W)	22.	1.831	.083		
Total	95.	101.936	1.073		

APPENDIX 9

Single Lever Study: Starting Speeds Across Trial Blocks for each Reinforcement Condition

APPENDIX 10

Blocks (four trials/block)

Single Lever Study: Movement Speeds Across Trial Blocks for each Reinforcement Condition

APPENDIX 11

Definitions of Abbreviations

- CE - the change effect - The finding in many of the stimulus familiarization studies of faster responding on trials where the signal to respond was different from that used on the previous trial.
- E - the experimenter.
- FFS - following a familiar stimulus - Refers to the double lever study. The designation for a trial on the second lever which follows the presentation of a FS as "reinforcer" for the preceding lever box 1 response.
- FNS - following a novel stimulus - Refers to the double lever study. The designation for a trial on the second lever which follows the presentation of a NS as "reinforcer" for the preceding lever box 1 response.
- FS - the familiarized stimulus - The stimulus which was repeatedly presented to the subject in the familiarization phase.
- NS - the novel stimulus - This stimulus is considered novel as compared to the familiarized stimulus.
- OR - the orienting response - The orienting response is a complex of responses (reflex and operant) including short latency attentional and associative components and longer latency motivational components.
- OR-habituation hypothesis - The hypothesis is outlined on pages 29 and 30.
- S - the subject.
- SFE - the stimulus familiarization effect - Refers to the finding of faster responding on a reaction time task when NS is the signal to respond as compared to when FS is the signal to respond.