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ABSTRACT

This study using the Visual Expectation Paradigm explored ways in which predictability of stimulus location and time of appearance affect the formation of expectations in infants of 3 months. A total of 64 babies were randomly assigned to one of four groups that differed by predictability of stimulus location and time of stimulus appearance. Infants were presented 70 pictures in a session of approximately 2 minutes. Pictures appeared randomly in 1 of 6 locations. The inter-stimulus interval was a mixed series of 700, 1,000 or 1,300 milliseconds (ms). Ten identical events were built into the sequence for each group. These "critical events" occurred on every sixth picture and consisted of a picture presented six degrees to the left or right of visual center. This picture was always preceded by a picture on the opposite side and a 1,000 ms no-stimulus interval. The infant's right eye was videotaped using standard infrared corneal reflection techniques. Findings indicated that predictability of location positively affected response time, while predictability of time of appearance did not. However, evidence was found to substantiate the claim that predictability of time of appearance can affect performance. Anticipations were more frequent when both time and location were predictable than when only location was predictable. (RH)

Predictability and Its Effects on Infant Visual Expectations

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ABSTRACT

Recent studies using the Visual Expectation Paradigm have shown that 3.5-month-olds rapidly develop expectations for the appearance of sequential visual events when both the location and time of appearance of the events were predictable. Expectations were inferred from an increase in anticipatory eye movements or a decrease in reaction time (RT) over control comparisons.

We designed this study to explore how location and time predictability separately affect the formation of expectations in 3-month-olds. Babies were randomly assigned to one of four groups: Group 1, location and time of appearance were predictable; Group 2, only location was predictable; Group 3, only time of appearance was predictable; and Group 4, neither location nor time was predictable.

Averaging across groups, location predictability (Groups 1 and 2 vs Groups 3 and 4) positively affected RT while time predictability (Groups 1 and 3 vs Groups 2 and 4) did not. However, we also obtained evidence that time predictability can affect performance as well. Anticipations were more frequent when both time and location were predictable (Group 1) than when only location was predictable (Group 2).

Thus, the two measures of expectation that we used were not completely concordant. Spatial predictability affected RTs whereas both spatial and temporal predictability seemed to be necessary for the increased production of anticipations.

QUESTION: How do time and location predictability affect the formation of expectations in the Visual Expectation Paradigm?

INTRODUCTION

Haith, Hazan & Goodman (1988) reported that 3.5-month-olds can detect a simple space-time rule for the appearance of sequential visual events and develop expectations for events based on that rule. Expectations were indexed in two ways: decreased reaction times (RT) to the picture (facilitation) or eye movements to the location of the picture prior to its appearance (anticipations).

In the Haith et al. (1988) study, location and time predictability were always linked. That is, either a sequence was spatially and temporally predictable, or it was neither spatially nor temporally predictable. In this study, we separated location and time predictability to examine how each affects the formation of expectations. Table 1 presents a summary of the experimental design.

METHOD

SUBJECTS: Sixty-four 3-month-old infants.

PROCEDURE: Infants were presented 70 pictures in a session that lasted about 2 minutes. When a picture appeared, it moved up and down, while a sound was presented from a centrally-located speaker. All pictures and sounds were presented for 700 ms and were followed by a no-stimulus (or inter-stimulus, ISI) interval. Babies were randomly assigned to one of four groups. 1) <u>Group 1</u> -- <u>Time and Location predictable</u>. Pictures alternated in a left-right (L-R) pattern with a 1000 ms ISI between each picture; 2) <u>Group 2</u> -- <u>Loctation Only Predictable</u>. Pictures alternated in a L-R pattern, and the ISI was a mixed series of 700, 1000, or 1300 ms; 3) <u>Group 3</u> -- <u>Time Only Predictable</u>. Pictures appeared randomly in one of 6 locations, and the ISI was always 1000 ms; and 4) Group 4 -- Unpredictable. Pictures appeared randomly in one of 6 locations, and the ISI was a mixed series of 700, 1000, or 1300 ms. (See Table 1 for a summary of the groups.) Ten identical events were built into the sequence for each group. These "critical events" occurred on every sixth picture and consisted of a picture presented 6° to the L or R of visual center; this picture was always preceded by a picture on the opposite side and a 1000 ms no-stimulus interval. Differences in performance between groups on the critical trials presumably reflected differences in the rule that infants learned from noncritical events.

DATA REDUCTION: The infant's right eye was videotaped using standard infrared corneal-reflection techniques. The tape was later analyzed in slow motion. A median RT was computed, and RTs were also subdivided into categories of fast (200 - 300 ms), intermediate (301 - 466 ms), and slow (> 467 ms). Anticipations were defined as movements of the eyes to the location of the next picture either before picture onset or within 200 ms after its onset (the minimum RT in this situation for adults).

RESULTS

Critical Events.

Analyses of variance were carried out only on the 10 critical events for comparisons involving groups 3 and 4, so all measures refer exclusively to the +/- 6° horizontal locations. (See Table 2 for a summary.)

1) Space and time predictability. The first analysis compared the performance of groups 1 and 4. Confirming prior studies, the series that combined space and time predictabiltiy produced a significantly higher % of

fast RTs ($p<.05$) and a significantly lower % of slow RTs ($p<.05$) than a series that was unpredictable in space or time. No stable effect on the % of anticipations occurred, probably reflecting relatively unstable estimates that could be obtained with only 10 events.

2) The graded effect of predictability. The next set of analyses examined linear trends across the various levels of predictability. A significant linear trend was obtained for the % of slow RTs with the % increasing as predictability declined ($p<.01$). Examination of Table 2 reveals that this trend primarily reflected differences between the two space-predictable groups and the two groups for which spatial location was unpredictable (Groups 1 and 2 vs Groups 3 and 4). A planned comparison between these groups revealed a stable difference ($p<.01$). A similar comparison for median RT was also stable ($p<.05$). Comparisons between the time-predictable and time-unpredictable groups (Groups 1 and 3 vs Groups 2 and 4) yielded no stable effects.

Other events.

Because babies in Groups 1 and 2 saw all the pictures at the +/- 6° horizontal locations and differed only in the predictability of picture onset, it was possible to use the full data set of 60 events (rather than only the 10 "critical" events) to test for the effect of time predictability.

3) The specific effect of time predictability. This third set of analyses compared the performance of groups 1 and 2 for all 60 pictures. In contrast to the prior analyses, there was a significant diffence for % anticipations with the difference favoring group 1 (See Table 3, $p<.05$). There was no effect on RTs. Thus, when all trials could be considered, time

predictability did have an effect on expectations.

CONCLUSION

In examining the same 10 "critical" events for all four groups, we found that as predictability increased the % of slow RTs that 3-month-olds produced, declined. We also found that when spatial location was predictable, babies made fewer slow RTs than when it was not predictable. For visual anticipations, we found no differences in the critical trials. However, when we compared two groups which both received predictable locations for all pictures, babies who had predictable timing made a larger % of anticipations than those who did not.

Results were not as strong as for prior studies due, in part, to the small number of "critical" trials that were available, given the design of the study. In addition, this is the first study we have conducted that presented sounds concurrently with the pictures. It is possible that the infants were overloaded by the stimuli and could not commit as many resources to the detection of regularity in the sequences as might otherwise have been possible. Even with these qualifications, there are several indications in this study that both spatial and temporal predictability are important for young infants in the formation of expectations.

		TIME BETWEEN PICTURES	
		PREDICTABLE	UNPREDICTABLE
PICTURE LOCATION	PREDICTABLE	GROUP 1	GROUP 2
	UNPREDICTABLE	GROUP 3	GROUP 4

TIME BETWEEN PICTURES
- PREDICTABLE: 1000 msec between each picture
- UNPREDICTABLE: 700, 1000, or 1300 msec between each picture (randomly assigned)

PICTURE LOCATION:
- PREDICTABLE: Pictures alternate on the left and right
- UNPREDICTABLE: Pictures randomly appear in one of six locations (except for built in critical trials)

TABLE 2

Means of the critical trials and significance level of the analyses

	GROUPS 1	2	3	4	Linear Trend	Contrasts 1 vs 4	1+2 vs 3+4	1+3 vs 2+4
REACTION TIME MEASURES								
Median RT	503ms	488ms	545ms	541ms			*	
% Fast	11..	5.8	5.7	5.0		*		
% Slow	52.8	51.5	65.5	69.4	**	*	**	
ANTICIPATION MEASURE								
% Anticipation	20.6	17.3	19.5	12.5				

One-tailed values
- * $p < .10$
- * $p < .05$
- ** $p < .01$

TABLE 3

Means of the events (critical and other) for Groups 1 and 2. Location is predictable for both Groups, Time is predictable only for Group 1.

	GROUP 1	GROUP 2	SIGNIFICANCE
REACTION TIME MEASURES			
Median RT	525	498	
% Fast	8.4	6.4	
% Slow	61.2	54.1	
ANTICIPATION MEASURE			
% Anticipation	22.0	15.8	*

One-tailed values
- * $p < .10$
- * $p < .05$
- ** $p < .01$