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THE EFFECT OF STIMULUS COMPLEXITY UPON THE FREQUENCY – AFFECT RELATIONSHIP

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The present experiment explores the effect of stimulus complexity upon the frequency-affect relationship. Repeated exposure of very complex stimulus patterns was expected to result in a U-shaped frequency-affect relationship while repeated exposure of simple patterns was expected to result either in an inverted-U or in a decreasing frequency-affect relationship. The results confirmed very clearly the first expectation ($p < .01$) but not the second one since the frequency manipulation had no effect upon the liking of simple stimuli.

Zajonc (1968) observed that the favorability of affective ratings of nonsense words, Chinese characters, and photographs of men was a *linearly* increasing function of the logarithm of their exposure frequency. This finding has since then been replicated in many other studies using different types of stimuli, other exposure frequencies, and largely different experimental situations (see Harrison, 1977, for a review).

On the other hand, several investigators have clearly demonstrated that stimulus complexity is an important determinant of the shape of the frequency-affect relationship. Berlyne (1970), Cantor (1968), and Smith and Dorfman (1975) found that liking only increased as a function of exposure frequency when complex stimuli were used. With simple stimuli, liking decreased as frequency increased. Saegert and Jellison (1970) and Smith and Dorfman (1975) observed also that liking first increased and then decreased as a function of exposure frequency when stimuli of a moderate complexity level were used.

These different shapes of the frequency-affect relationship can easily be explained by Berlyne's (1967, 1970, 1973) model about the determinants of a stimulus' hedonic value. Hedonic value, a term which refers to reward and incentive value as well as to degree of pleasure and preference, can be acquired by a stimulus in two ways. First, any situation that increases arousal to a high level is aversive

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so that a stimulus that decreases arousal will be rewarding and pleasant (the arousal-reduction mechanism). Secondly, any stimulus that increases arousal to a moderate extent will be rewarding and pleasant (the arousal-boost mechanism).

Berlyne's conception of the arousal-boost mechanism relates the hedonic value of a stimulus to its arousal potential. Arousal potential refers to the capacity of a stimulus to raise arousal and it is determined by the stimulus' psychophysical, ecological, and collative properties (Berlyne, 1971). The relationship between arousal potential and hedonic value is a curvilinear one with a maximum preference for a moderate amount of arousal potential.

Repeated contact with a novel stimulus will reduce its novelty and consequently its arousal potential. The effect of this reduction on the hedonic value of that stimulus depends then on its initial amount of arousal potential. When the novel stimulus is also highly complex, it will contain a high amount of arousal potential. Repeated exposure to such a stimulus will reduce its arousal potential and bring it nearer to the optimally preferred amount. As a consequence, the hedonic value of the stimulus will be an increasing function of exposure frequency (at least within a certain frequency range). A moderately complex stimulus will contain an amount of arousal potential which is nearer to the optimally preferred amount. Repeated exposure of this stimulus will reduce the arousal potential and will, after a relatively small number of exposures, make it infra-optimal. Consequently, the hedonic value of this stimulus will be an inverted-U function of exposure frequency. Repeated exposure of a fairly simple stimulus, containing only a small amount of arousal potential, will reduce its arousal potential so that it becomes even further removed from the point of maximum preference. The hedonic value of this stimulus will then be a decreasing function of exposure frequency.

Vanbeselaere (1975, 1977) found still another type of frequency-affect relationship, namely first decreasing and then increasing. This finding was interpreted by suggesting that the stimuli used in these experiments were probably much more complex than the ones used in comparable studies. This suggestion implicitly assumes then that a very complex stimulus would contain more arousal potential after a few exposures than at its first exposure. This assumption receives support from a study by Davis (1934). He found that the repeated exposure of a very complex selection of classical music increased that stimulus's arousal potential (measured via the GSR) while the GSR reactivity decreased when simple stimuli were repeatedly presented.

Although stimulus complexity is clearly a very important variable, the problem with manipulations of complexity is that the term is not unambiguous and that the definition of complexity varies with the investigator who uses it. This state of affairs does not only make it difficult to compare different studies but points also to the necessity of having a large set of stimuli whose complexity is clearly defined and is varied systematically along the complexity continuum.

Smets (1973) constructed a set of stimuli satisfying this condition by photographing patterns of 450 black and 450 white squares. Their complexity was defined in terms of maximal information (*H* max) and subjective redundancy. Since the patterns are composed of 450 black and 450 white seperate elements, they have an *H* max of 900 bits. The subjective redundancy of a pattern was measured by asking subjects to reproduce the pattern after it was presented for 2 seconds. Subjects had to start their reconstruction at the top left-hand corner and they had to work square by square, column by column. For each square, they had the choice between white and black and the percentage of correct choices was taken as a measure of redundancy. As complex stimuli; 6 patterns were used having an *H* max of 900 bits and a subjective redundancy of only 20%, *i.e.* the subjects made 40% erroneous choices in reconstructing the patterns (for a completely random pattern, one would expect 50% erroneous choices). Six patterns with an *H* max of 900 bits and a subjective redundancy of 80% (*i.e.* subjects made only 10% erroneous choices in reconstructing the patterns) were used as simple stimuli.

It is almost impossible to predict a priori what type of frequency-affect relationship will be obtained with these stimuli. Although several studies demonstrated the importance of the complexity variable, it is still impossible to predict at which complexity level a specific type of frequency-affect relationship will be obtained. Smith and Dorfman (1975) used comparable stimulus patterns but they measured complexity only in terms of *H* max and did not take subjective redundancy into account. Using 3 complexity levels, *i.e.* *H* max of 4, 16, and 36 bits of information, they found that liking, as a function of exposure frequency, decreased for the simple stimuli, first increased and then decreased for the intermediately complex stimuli, and increased for the complex stimuli. These data still do not make it possible to predict what type of relationship will be obtained with our stimuli. Given the high subjective redundancy of the simple stimuli (*H* max = 900 bits, subjective redundancy = 80%), one could expect however that the frequency manipulation would result either in a decreasing frequency-affect relationship or in an inverted-*U* relationship. For the very complex stimuli (*H* max = 900 bits, subjective redundancy = 20%) on the other hand, it could be expected that liking would either increase linearly or increase only after an initial decrease. This last prediction implies then that our assumption concerning the impact of a few short presentations of a very complex stimulus on that stimulus's arousal potential is correct.

METHOD

SUBJECTS

*S*s were 72 first year psychology students, who volunteered to participate. *S*s were randomly divided over the two complexity conditions and each condition contained an equal number of males and females.

STIMULI

The stimuli were black and white pictures of the stimulus patterns constructed by Smets (1973). Six patterns had an H max of 900 bits and a subjective redundancy of 20% (complex stimuli) and six had an H max of 900 bits and a subjective redundancy of 80% (simple stimuli). The pictures measured 5.0×5.0 cm and were pasted in the center of 7.5×12.5 cm index cards. The six stimuli of each set were counterbalanced against six frequency conditions (1, 2, 5, 10, 25, and 50) in a 6×6 Latin square design which was replicated six times in every condition.

PROCEDURE

The procedure was exactly the same for both complexity conditions.

Stimulus presentation: *S*s, who were run individually, were told that they would see a series of visual patterns and they were instructed to pay close attention to them. They received a package of 93 cards on which the stimuli were pasted. The stimuli were presented in a random order which was different for every *S*. *S*s had to look at each card for three seconds and then turn it over. *E* gave a signal every time.

Rating phase: After a detailed explanation of how to work with a nine point rating scale, *S*s were asked to indicate how much they liked each pattern.

Debriefing: *E* then explained very briefly the purposes of the study. After all *S*s were run, a more detailed explanation was mailed to all participants.

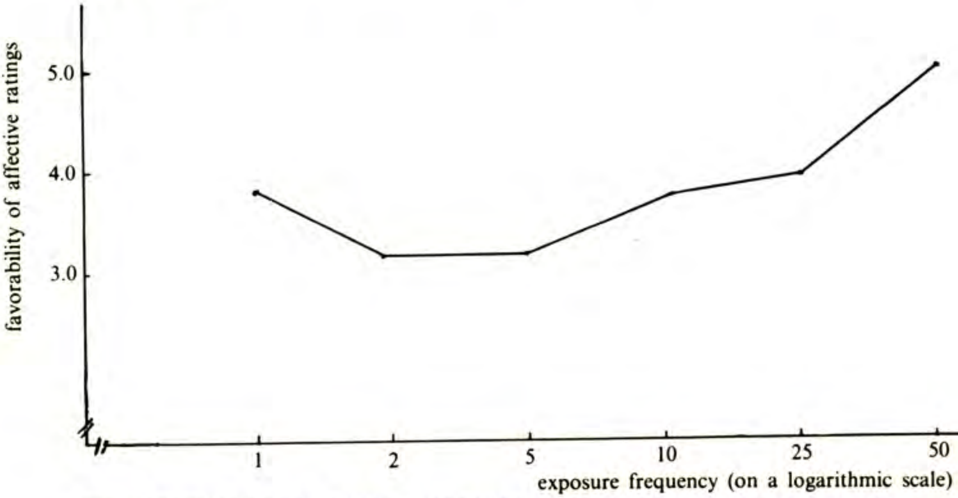

FIG. 1. FAVORABILITY OF AFFECTIVE RATINGS OF COMPLEX STIMULI AS A FUNCTION OF EXPOSURE FREQUENCY

RESULTS

Ratings were scored 0-8, with 8 indicating greatest liking. For the simple stimuli, the frequency manipulation had no effect at all ($F < 1$) upon the favorability of the ratings. For the complex stimuli, the frequency manipulation had a very significant effect ($F = 3.57$, $df = 5/150$, $p < .01$) upon the favorability of the ratings (see Figure 1). The trend analysis revealed that both linear and quadratic trend components were very significant ($F = 8.62$, $df = 1/150$, $p < .01$, and $F = 8.08$, $df = 1/150$, $p < .01$, respectively). They accounted respectively for 48% and 45% of the variance associated with the frequency manipulation. The stimuli themselves did not differ among each other ($F = 1.14$, $df = 5/150$, *N.S.*).

DISCUSSION

Mere repeated exposure to very complex visual patterns results in a clearly *U*-shaped frequency-affect relationship. In order to be able to interpret this finding within Berlyne's theory, it is necessary to assume that a very complex stimulus contains more arousal potential after a few short presentations than on its first presentation.

As already mentioned in the introduction, Davis (1934) found that this was indeed the case. This finding was interpreted by suggesting that a very complex musical selection contains so many elements that it is impossible to perceive them all on the first presentation and that some aspects of the stimulus are only observed after a certain number of presentations. Consequently, the stimulus would be more complex after a few presentations than on the first presentation.

A similar interpretation could be advanced for our data. Smets (1973) noted that the subjective redundancy of a stimulus pattern is largely determined by the degree of structure within the pattern. The very low redundancy of the complex patterns indicates then that they are very poorly structured. Since there is no structure clearly dominating the whole stimulus pattern, a few short presentations could have as a consequence that the subjects are able to distinguish more and more elements in the complex pattern without having the possibility to integrate these elements in some encompassing structure. This integration might only be possible after a relatively high number of presentations. The liking data do of course not demonstrate that, as a function of exposure frequency, these differences in perception actually occur and that they cause differences in the stimulus's arousal potential. This should be tested in a much more direct way.

This initial decrease of liking when very complex stimuli are used, is not easily accounted for by Stang's (1974 & 1975) learning interpretation of the mere exposure effect. He proposed that repeated exposure results in learning about the novel stimulus. This learning would be intrinsically rewarding and liking would be then a linearly increasing function of degree of learning. Since novel or complex stimuli are initially less well-learned, more learning can occur, and hence the exposure effect will be more easily obtained than when familiar or simple stimuli are used. This interpretation of the mere exposure effect cannot explain then a *U*-shaped frequency-affect relationship for very complex stimuli unless one would assume that with this type of stimuli the initial learning is not intrinsically rewarding.

Repeated exposure to the very simple patterns did not influence the subsequent liking at all ($F < 1$). This cannot be attributed to the type of stimulus material used since these simple patterns are of the same kind as the complex ones. Moreover, exactly the same procedure was used for both complexity conditions. Considering then that these two conditions only differ with respect to the complexity of the stimulus patterns, this factor must be responsible for the different effect of the frequency manipulation. However, it is not so clear why the frequency manipulation has *no* effect upon the liking of these simple stimuli, especially since several studies clearly demonstrated that liking of simple stimuli typically decreases as exposure frequency increases. However, as already pointed out in the introduction, it is impossible to compare the complexity of the stimuli used in different studies.

Although stimulus complexity thus clearly is a very important determinant of the frequency-affect relationship, it is also clear that the effects of stimulus complexity should be explored in a much more systematic way. In the first place, in order to be able to compare the results of different studies, it is necessary that different researchers would work with stimuli whose complexity is defined in the same way. Second, it seems also necessary to use a set of stimuli varying systematically over a wide complexity range instead of realizing only two or three complexity levels. It is only in this way that the effects of stimulus complexity upon the frequency-affect relationship can be fully explored. The set of stimulus patterns constructed by Smets seems to be very appropriate for achieving this goal.

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