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THE ORGANIZATIONAL FUNCTION OF EMOTION ON COGNITIVE TASK PERFORMANCE IN INFANCY

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On the basis of a set of laboratory experiments, this report deals with the organizational functions of emotion with the conclusion that emotions of variant hedonic tones produce organizational or disorganizing effects on cognitive task performance. The discussion centers around what are the factors through which emotion impacts cognition. It analyses the following facts: the physiological arousal and the interior experiences as important components of emotion take parts in the impacts on cognition; the impacts of emotion are functioned by way of a form of motivation; the crux of these functions rests with the impacts directly upon the alternative of cognitive operating strategies.

The functional value of emotion had been examined actually from different perspectives first by Freudianism and then by Humanistic Psychology. However, during those years when Behaviorism was dominating over psychology and cognitive psychology was on the rise, emotion was in the eyes of many psychologists merely a reaction to behavior or an outcome of cognition. Consequently, the study of the role of emotion had been held back on the theoretical level for a considerable period of time. It was true that not every school of the cognitive approach ignored the effects of emotion on cognition completely; but it was on the dominant position theoretically and empirically.

Only since the 1960s, another line of psychologists had began to develop the research on functional value of emotion on the basis of modern science of human brain. In doing so, the theoreticians had reviewed the Darwinian theory of emotion adaptability, adopted part of the essence of psycho-analytic, and used for reference some views of contemporary doctrines of ethology. Thus came into a new stage of being another increasingly influential branch of emotion theory and study.

In the meantime, a lot of problems concerning emotion have arisen from the everyday social life, in which what people actually experience is, firstly, such feelings as joy or distress, sadness and anxiety. In one way or another, emotion always asserts itself on the surface, and at the same time in the innermost, of people's psychological

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life. Is it conceivable that, while hunting people's psychological scenes, these elements of feelings would not produce upon them any impacts, either physically or mentally, intellectually or personally? The reality life have stimulated the psychologists to probe into the inner world of man, and these endeavors made many scientists feel it necessary to shift the focus of their attention from practical applications to the study of emotion, particularly in the field of developmental psychology, and practical and basic theoretical researches of emotion have been engaged.

Over the recent decade, emotion psychologists have been advancing a hypothesis that emotion is of an organizational function. As a kind of psychological function, emotion plays an important role on the adaptability for existence and serves in the interpersonal communication. During the period of prelanguage in infancy, the psychological communication between the infant and adult is linked up not by language, but by the interaction of affectional signals. These linkages to a large extent ensure the existence and growth of the infants on the perspective of human evolution. On the basis of the input of sensory signals, infant's emotions intervene and organize their cognitive processes and behavior. This eye-opening proposition has shed light on a new dimension for the people who are exploring the concrete functional effects of emotion, particularly for those who are interested in the interaction between emotion and cognition.

Part of our work have concentrated on the effects of variant emotional states on cognitive performance with the infant subjects in the laboratory for dual objectives. First, the work is based on basic terms. We decided to use infants as subjects in order to place the conditions under the fullest possible control for strict laboratory experiments. For instance, when emotions are elicited as independent variables under laboratorial situation, the subject is prone to be influenced by such factors as his/her own intrinsic emotional tendency and extrinsic environment. The older his/her age is, the more complicated these factors are. Therefore, we take infants as subjects primarily because that the prelanguage infants are relatively much simpler in this respect. Secondly, we have directed the research in an attempt to bring to light the role of non-intellectual factors in child development from the perspective of developmental psychology. Though not beyond the framework of basic theoretical study, this idea is of distinct value in application. People attach more importance in China nowadays, to the child's intellectual factors than to the non-intellectual ones; and, of the later most attention has been centered on the factor of personality characters. They tend to overlook the nature of emotion and its functions on intellectual development, personality formation, and even physical growth. This is another reason behind our decision to take infants as subjects in the experiments on emotion-cognition interaction. We have engaged in a number of experiments on this issue since the end of the last decade. This report is a summing-up from those studies.

THE INFLUENCE OF DIFFERENT EMOTIONS ON COGNITIVE PERFORMANCE.

There are different effects of variant hedonic emotions on cognitive performance. It is a common knowledge that emotion assumes such forms as joy, anger, sadness,

fear etc. in the science of psychology, however, emotion had been studied for long as an undifferentiated entity. However, it seems to us a dead end if we regarded as an indivisible whole in the attempt to further uncover its functions. Actually emotion is an manifold forms of differentiation and combination with very complex and very different functions. This convinces us of the special significance in treating the differentiation and classification of concrete emotion at the theoretical level, it would lead the study on such as variant concrete emotions' characters and functions, the interactions among them, their connections to cognition and behavior, and the wide functional variety in which they condition the human psychological life. Under this idea, our efforts have involved experiments on the effects of variant emotions on intellectual task performance, comparing the functional differences between joy and distress, interest and fear, anger and non-anger, etc.. The subjects were adopted from the 16-18 months old infants.

Upon these experiments, a general tendency is that the subjects complete the task performance faster in positive emotional background than in negative situations. This can be illustrated by an overall outcome of comparison. Each of the three pairs is designed to perform a task of its own after the emotions are elicited. Of all the three sets, the diversity in the length of time needed for every one to finish the task is remarkable. Thus the variety of functional value of the positive and negative emotions are illustrated (see Table 1).

TABLE 1

The comparison of overall differences between passive and negative emotions on cognitive performance

Happiness	Distress	Interest	I & F merged	Fear	Nonager	Anger
125.2	174.7	46.6	72.0	178.0	100.4	142.1
t=2.19			F=104.65		t=2.53	
df=111			df=58		df=71	
p<0.05			p<0.01		p<0.02	

As we know, joy is the most general form of positive emotion with remarkable degree of positive hedonic tone. It brings a lucid and lively tone to the background of people's feeling. During the test we've observed that joy is of relax character, it places the child in harmonious coexistence with others, positions the child in a state of transcendence and freedom. This emotional state makes the child extroversive and hospitable to the outside world, and easy to get interested in things. This phenomenological analysis of joy we have watched can offer an explanation why emotion provides a beneficial condition for information processing.

Opposite to joy, distress is the most general form of negative emotions. Distress is basically unpleasant with a high degree of tension. It centers the people's experience in an overcast and dejected state, and brings memories of suffering content, scribbling the background of the feelings with a strengthless and discouraged state. In the laboratory, after the removal of the causative factor of distress, the subjects show certain extent of behavior inhibition, reflecting lack of impetus and enthusiastic attitude toward the designed permanence, and a simplistic performance strategy is taken, and

always with a fussing temper, resulting in a prolongation of time. Consequently, the stronger the distress in the test, the longer the performance time.

Similarly, interest is a major positive emotion, too. Elicited upon the appearance of a novel stimulus, it is the direct motive factor of information processing with a moderate degree of activation and tension. However, the novel stimulus could elicit of interest as well as of fear. This depends on the degree of the novelty of the outside world and the individual differences. Fear is the most detrimental one of the emotional states. With an extremely high degree both of tension and impulsiveness and an extremely low degree of self-confidence, it is prone to shrinking back, shirking away and seeking help. Therefore, although fear and distress as the negative emotions have different causative factors, both result in inhibition and downheartedness. Particularly under the condition of fear, the phenomena such as confusion in problem solving, clamminess in performance and slowness in learning manifest them in the length of performance time which is distinctly longer than that needed under the situations of interest and joy.

THE RELATION BETWEEN INTENSITY OF EMOTIONAL AROUSAL AND COGNITIVE PERFORMANCE.

However, it is not only the hedonic tone of the concrete emotions are provided with the different role to the cognitive activity, but the variant degree of emotional intensity also plays differently on the cognitive processing. Our study involves in the Yerkes-Dodson law. It takes the level of general arousal of emotion as independent variable, demonstrating the impacts of variations of intensity on manual task performance with an inverted "U" figure. Anyway, how do we consider about under the circumstances of variant concrete emotions? Our experiments illustrated that there are differences among variant emotions on the interaction between variant degrees of emotional intensity and the effects of cognitive performance. They are: A "U" curve, similar to that under the Yerkes-Dodson law, is attained from the joyful state of emotion, showing that it is comparatively more difficult for cognitive performance to reach the best result in either excessively high or excessively low degree of joy than in a moderate degree of the emotional state. In contrast to this, an upward sloping line comes out of a situation of distress, illustrating that the higher the degree of the emotional state is, the more unsatisfactory the performance effects are. And a liner results from the situation of fear which are similar to that of distress and demonstrated (Figure 1-4).

This result is calculated by the method of curvilinear regression in terms of η . The characters and forms the attained curves assert themselves in a comparison between η and product moment coefficient of correlation, r . both within the range of 0-1. When the values of η and r are close to each other, its points to a straight line correlation; conversely, it means a curve line correlation.

How do we explain the above demonstrated functional differences on intensity between positive and negative emotions? Joy provides, generally speaking, a favorable environment for intellectual activities. However, under the dimensional analysis of emotion, the impulsive dimension of joy has a considerable range of variation. When

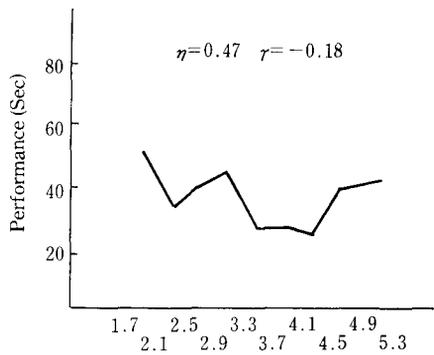


FIGURE 1 Smiling & Laughing(Ln)

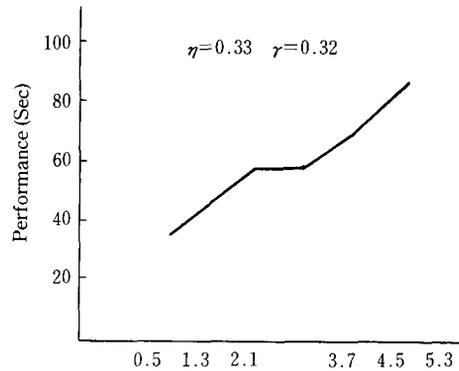


FIGURE 2 Crying & Pouting(Ln)

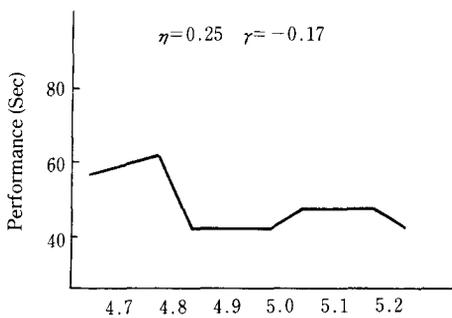


FIGURE 3 Interest(Ln)

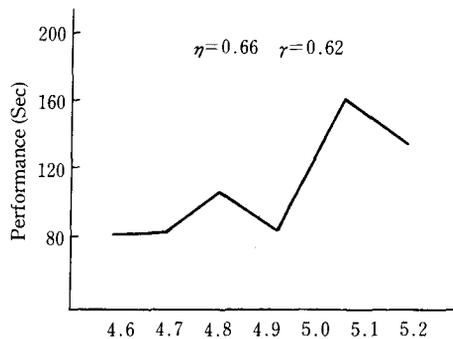


FIGURE 4 Fear

in such a state, you can be very excited, you can also be relatively quiet. And the degree of the impulsiveness is, to a great extent, directly proportional to the degree of intensity. Yet, joy is relaxed on the whole range, it does not show the evident variation on the dimension of tension-relaxation. From this point of view, and excessively high degree of impulsiveness of joy tends to undermine the optimum for intellectual processing; and it is hard for an excessively low degree of excitation to bear enough energy for cognitive processing. It can be said that the impacts upon the cognitive performance under joyful state, are mainly determined by the variant degrees of impulsivity.

On the other hand, negative emotion, such as distress or fear, are of a negative character in their degree of hedonic tone. Being unpleasant, the protruding point is, it possesses a considerable high level of tension. Both the unpleasant feelings and the state of tension interrupt the task performance. The more intense their unpleasant and tense dimensions are, the more obstructive to cognitive performance they will be. For instance, distress brings about evident inhibition which undermines the functions of cerebral cortex, resulting in an unfavorable condition for cognitive performance. Fear leads to an evident shrinkage in behavior with a high degree of tension and some times of excitation. Its destructiveness is even worse than that of distress.

In addition, interest emotion, in terms of correlation between the time of occurrence and the effects of performance, produces an approximately level line with slightly

downward, illustrating that better performance is appeared alone with longer duration of interest is elicited (see Figure 1, 3). This reflects that interest is an emotional state of moderate activation which is neither excessively high nor excessively low. Thus the state of the cortex with an interest tone is the best state for cognitive processing.

All of these results illustrated that concrete emotions upon the variant levels of intensity, possess the functional value differently.

THE FACTORS THROUGH WHICH EMOTION IMPACTS COGNITION

1. The above-illustrated set of experiments demonstrate that emotion impacts directly upon the alternative of cognitive operating strategies and the intensity of performance motivation. I'll only take the joy-distress task as an example. The subjects adopt three performance strategies, namely, "direct grasp" (DG), "passive looking" (PL) and "detour reaching" (DR). However, the subjects adopt the three strategies distinguishingly under variant hedonic emotions (see Table 2). The subjects in distress spend more time performing DG and PL behaviors than the subjects in joy. DG is simplistic approach, dominated directly by the achieving motivation. It does not involve and hold alternatives of performance, typically represents the rigidity and stereotyped processing tendency. For dealing with the detour task, the skilled motor performance and learned experiences are involved. The subjects must make use of perceptual cues, through the process of trial-and-error to recognize the linkage of the motor action by hands and the out of reach object; to generalize the motor action and to assimilate the response of problem-solving. However, the simplistic DG strategy does not enable the child to establish these psychological skills. Thus we assume that the impact on performance is determined by the valid or invalid of the performance strategies, which are adopted under the background of either positive or negative emotions.

TABLE 2
Correlation ratio between intensity of emotion and cognitive performance

	Correlation ratio (η)	Coefficient correlation (r)
Joy	0.47	-0.18
Distress	0.33	0.32
Interest	0.25	-0.17
Fear	0.66	0.62
Anger	0.50	-0.19

"Passive looking" demonstrates typically the motivational state of the subjects. The distress subjects lose the interest for getting the toy than the joy subjects. In this sense, emotion plays a role of motivation, or, it impacts the motivational state by which the child is engaged in activities. As we said previously, joy state enables people extroversive and hospitable to the outside world and easy to get interested in things, the subjects represent willing to engage to the detour task; whereas distress state makes the subjects downheartedness and discouraged, loses their interest and lack in strength for their bodily activity. This phenomena illustrated that variant emotions are differ in carrying energy and playing the role for encouraging the people to act.

2. We have mentioned previously that it is just the impulsiveness levels of the joy state impact the performance. This phenomenon lead us to consider further the question of roles of physiological arousal and then the question of the subjective experience upon the emotion-cognition relationship. If the intermediate levels of joy elicitation create an optimal physiological state for cue utilization and response regulation in task performance, the physiological state underling the emotion may also be a factor which influence task performance. Let's assume that heart rate changes play a role in information intake and regulation of impulsivity, with greater decelerations being linked to better information processing and response regulation. According to J. Campos and R. Emde, the greater intensities of negative emotion, such as distress, result in progressively larger cardiac accelerations, and the greater intensities of positive emotion, such as joy, result in greater decelerations, but only up to a point at which further increments in joy result in modest accelerations. This idea represents that heart rate may be optimally deceleratory for problem-solving at intermediate levels of joy elicitation, resulting in good detection of information about the subjects attempt to obtain the desired toy, and good inhibition of irrelevant responses. Whereas at both low and high levels of joy, heart rate may be at less optimal levels, being minimally deceleratory in periods of short duration of joy and possibly even acceleratory following very exciting and long-duration bouts of smiling and laughter. In both cases, physiological states underlying high and low intensities of positive affective response would be related to poorer performance. By contrast, the physiological states underlying greater intensity of distress would result in progressively poorer performance. These were just precisely the patterns we observed in these studies.

The phenomenon of cardiac decelerations in the intermediate levels of joy elicitation would be available to explain the level pattern in the situation of interest. It's well known that the heart rate is decelerated during interest arousal. Actually, the maintainness of interest to a certain objects of the outside world, the maintainness of heart rate on a certain level as well simultaneously, resulting the effect of performance to be stabilized. As we observed in the laboratory, interest and joy are always co-existed and happened alternately under either joy condition or interest condition. They're actually elicited and interacted with each other very often. We believe that the interaction and inter-complement of them provide the best psychological background for intellectual activities in infants and children.

3. However, the physiological arousal is a necessary aspect on the explanation for the question of the functional value of emotion, but not the best or not enough. We are enlightened to consider the function of the subjective experience while we engaged in an experiment of anger. We found that it seems two types of anger are appeared during anger elicitaion. We measured them and called them "expressed anger" (EA) and "suppressed anger" (SA). The main finding unexpectedly showed that the performance of expressed anger is better than of suppressed anger (see Table 3). I've explained that greater intensity of negative emotion resulted in progressively poorer performance. If this proposition is suitable for explaining the situation in anger, thus the expressed anger would show poorer but not better performance than suppressed anger, because, suppressed anger expressed less expressions, but it is just on the contrary.

TABLE 3

The comparison of cognitive performance between Happiness and Distress in different performing strategies

	DG	PL	DR	Total Time of DR
Happiness	7.75	1.82	19.79	98.32
Distress	13.31	13.04	21.09	134.10
	F=4.85*	F=18.53**	F=0.17	t=2.04*

We would make the following analysis by two points mainly :

- 1) The increment of tension while anger is inhibited.

By virtue of individual temperamental differences and the laboratory novel situation, some of the anger subjects fall into inhibition. Lower physiological excitation are elicited, as in the situation of slight joy elicitation, which results in insufficient energy supplement for cognitive activity, leads to the inverted U figure. While we examined the data and the figure, we found that most of the subjects who occupied the left end of the figure were suppressed anger subs. They are angry, but it is not expressed, a poorer performance is demonstrated. Whereas most of the subjects occupied the middle and right parts of the figure were expressed anger and with a progressive poorer performance along with the increment of greater intensity (Table 4, Figure 5).

TABLE 4

The comparison between Expressed anger and Suppressed anger on cognitive performance

	Expressed anger	Suppressed anger
\bar{X}_{sec}	39.1	51.9
S	17.575	27.604
N	30	21
F		4.393**

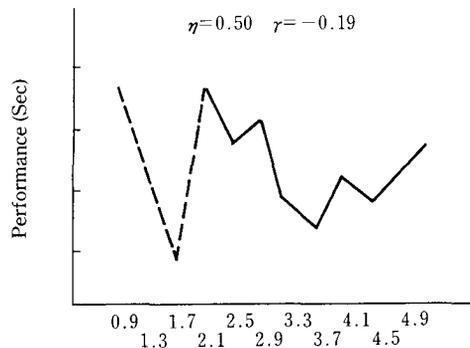


FIGURE 5 Anger(Ln)

Since the nature of anger are different from joy, there would be not only the impulsive dimension but also the tension dimension in anger are involved. Reports by H. S. Goldstein (1989) showed that, in adults, coping with anger by conscious inhibition of its expression is related with increment in blood pressure, particularly in

systolic pressure, but the expressed anger is only associated with diastolic pressure. This evidence seems to be an explanation in general that, while anger is expressed, tension is released, and better performance is demonstrated; whereas anger is existed and accumulated, tension is increased, and poorer performance is demonstrated. However, exploring the adequate indicators for measuring the tension dimension of emotion in infants is necessary.

TABLE 5
The contribution of Expressed anger and Suppressed anger subjects on the figure

Subject Contribution	elimination	left	middle	right
range	0-2.0 ln 0-7.4 sec 0-4.0%	2.0-3.3 ln 7.4-30.6 sec 4.0-17.0%	3.3-4.5 ln 30.6-90.0 sec 17.0-50.0%	4.5 ln- 90.0 sec- 50.0%-
Expressed Anger	0	2	20	8
Suppressed Anger	4	10	6	1

2) Interior experience

There would be stronger interior experience while anger is particularly existed potentially. On the problem of impacts of emotion on cognition, whether the interior experience plays a role at a certain extent? It seems to be without saying but is indeed hardly to be proved objectively. Some theories of temperament (Teplov, the distinguished Russian psychologist) explained that the Inhibitory Type possesses stronger interior emotional experience without much expressions. Particularly with the feeling of negative emotions, it expresses inhibition in affectional behavior results in more obstacles in information processing. More studies in our laboratory showed that the previous existed emotional experience impacts the post-elicited emotional expressions, evidenced by the reaction time of post negative emotion elicitation is longer than of post-positive emotion elicitation, while the physiological arousal has been eliminated (Chen, 1987). Further more, previous existed emotional experience impacts also the reactions of emotion communication and coping behavior of infants on the visual cliff, evidence by the comparison between joyful and fearful experience (Wang, 1988). Thus we use so called the method of elimination and comparison to illustrate the existence of subjective experience. We assume that the existence of the continuous interior feelings would be as a result of which it links with the contents of consciousness. Under the circumstance of our laboratory test, the continuous awareness of the situation of anger elicitation, maintaining the feelings of anger, would be the main reason which interrupts the task performance. Therefore, while the suppressed anger is existed potentially, its impulsiveness is inhibited, its tension is increased, and the interior emotional feelings is stronger. There would be the main factor which enable the suppressed anger subjects perform poorer than the expressed anger subjects.

Overall, these studies have an eye to the functional impact of emotion on cognition, explore the functional values of variant hedonic emotion. They are very initial, but I'm impressed by the above-discussed thoughts. However, more experiments are necessary for evidentially proving the hypothesis which I state in this paper.

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