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The Effects of Physiological Arousal and Unconscious Processing of Trait Words upon the Mechanisms of Social Cognition

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Abstract

Two experiments were conducted to examine effects of physiological arousal and unconscious processing of trait words on impression formation of others. It was predicted that cognitive complexity of others' impression would decrease in a high arousal state because attentional resource might be restricted in such a state. Furthermore it was hypothesized that the priming effect of trait word processing would be facilitated in a high arousal state. In each experiment, subjects rated the impression of a hypothetical target person after they processed hostile, neutral, or friendly words which were presented at a subliminal level in either high or normal arousal state. Results of both experiments made it clear that the impression of the person was simpler and more extreme in high arousal conditions. However, effects of unconscious priming were not found in each experiment. These results were discussed in terms of constructs accessibility models.

Introduction

Recently, a number of studies have been conducted to examine the influences of affective or motivational factors upon the processes of social cognition (e.g. Bower, 1991; Forgas, 1991). Little is known, however, about roles of one of the classical motivational factors, physiological arousal, in such processes. To examine the effects of arousal upon the processes of interpersonal perception seems to be important to understand the relationship between the affect and social cognition, because our experiences of any affect are often accompanied by arousal and it has been reported that the arousal influences the general cognitive performance (Eysenck, 1982).

It has been repeatedly maintained that the cognitive ability or performance is impaired in high levels of arousal. For example, it was reported that the performance

of a tracking task (Broadbent, 1971), short-term memory or incidental learning (Easterbrook, 1959), or recall of complex information (Eysenck, 1976) decreased in a high arousal situation. Kahneman (1973) argued that the poor task performance under high arousal is due to an interactive effect of attentional narrowing, heightened lability of attention, and impaired attentional discrimination. It has been also stated that in a high arousal state, simpler and heuristic strategies of information processing are likely to be adopted (Mandler, 1984), furthermore, information processing that depends on the schema or stereotype is facilitated (Baron, 1986), because of the decrease of attentional resource that can be allocated to the tasks in such a state. If these arguments are true, a similar mechanism may work in the social cognition or impression formation of other people. Namely, it may be expected that simpler and less effortful strategies to evaluate others and to form their impressions would be adopted in a high arousal state.

According to Kelly's (1955) personal constructs theory, it is assumed that individuals make multi-dimensional representations of others by using multiple trait categories, namely, constructs, that they have and integrate them to uni-dimensional information to form the impressions of others. This theory assumes that there is a large individual difference in trait categories that individuals have and use. Furthermore, this theory states that those perceivers' pre-existing construct system determines what they perceive in others. Thus, this formulation concentrates on the role of enduring cognitive representations in impression formation, and has little to say about the influences of situational or contextual factors. Recently, however, it has been shown that the accessibility of constructs or trait categories is varied by many situational factors and the number and content of constructs that are used for rating others are determined by such factors (Wyer & Srull, 1981; Bower, 1981). In this line of argument, it may be proposed that one of the effective strategies to simplify and to make effortless the process of interpersonal perception should be to use only a few trait categories for impression formation. This strategy makes it capable to spare both cognitive effort and time of processing. The impressions of others which are formed by such a strategy are expected to be simpler and more extreme than those that are formed by more elaborate and deliberate information processing.

In the present study, the notion of the cognitive complexity (Bieri, 1955) is considered as an index of both the number of trait dimensions used for rating others and the degree of complexity-simplisity of the impression of them. The cognitive complexity was originally defined as an individual difference variable, which varies according to the individual's ability to differentiate and integrate stimulus input, especially information of others. Cognitively complex individuals are considered to be able to use more trait categories, to integrate more information, and to represent others more richly than cognitively simple individuals. In the present study, however, the cognitive complexity is treated as situation dependent. Sakamoto and Numazaki (1989) showed that the cognitive complexity was very sensitive not only to the individual difference but also to some situational factors. Thus, it seems to be plausible to assume that the cognitive

complexity may be an index of the temporary state of information processing strategies. In a high arousal state in which the processing capacity decreases and simpler information processing strategies are motivated, the cognitive complexity of a target person's impression is expected to decrease. To examine this mechanism was the first purpose of the present study.

How does the change of the cognitive complexity influence the impression of others? The decrease of the cognitive complexity in a high arousal state may lead the impression to be simple, monotonous, and sometimes extreme because such an impression formation will be made by using only few constructs. In such a case, the feature of the impression may depend strongly on whether some contextual cues that may influence the processes of interpersonal perception exist or not. First, when any contextual cue does not exist, the information about a target person is expected to be processed by using few constructs that are especially pre-dominant for the perceiver (Higgins, King, & Mavin, 1982). Because of the individual difference of the enduring order of dominance of the constructs accessibility, each perceiver may rate information about the person based on widely different constructs. Thus, the defference of the impression of the person between perceivers in a high arousal state without contextual cues is expected to be larger than that in any other conditions. On the other hand, as perceivers may be able to use relatively more constructs in a low arousal state, they are likely to use common constructs to some degree. Hence, the difference of the impression is expected to become smaller.

Secondly, when some cues exist, the impression is expected to be determined by the various contextual cues. A number of studies have indicated that the accessibility of trait categories may be activated by various contextual and situatinal factors that relate semantically to the categories, resulting in that the categories are weighted in impression formation. It was reported that conscious (Higgins, Rholes, & Jones, 1977) or unconscious processing of trait words (Bargh & Pietromonaco, 1982), sentence-completion task relating trait categories (Srull & Wyer, 1980), and moods or affects induced by hypnosis or bogus feedback (Forgas, Bower, & Krantz, 1984; Forgas & Bower, 1987) influenced the subsequent impression formation. These studies have consistently indicated that the impression is often biased to the direction semantically congruent with the trait words or affects. For example, when hostile words were processed beforehand, the impression of a hypothetical target person who was described in several behavioral descriptions was likely to be rated more negatively. This phenomenon is usually explained in terms of a kind of priming effect in associative network (Wyer & Carlston, 1979; Bower, 1981, 1991). These theorists have insisted that processing of information related to particular trait categories or constructs temporarily facilitates the accessibility of the categories. Those trait categories or constructs are likely to be used in the subsequent impression formation. In this case, the dominant constructs used by perceivers are considered to be common to a high degree, resulting that the impressions will be biased and the difference of the impressions are expected to be small. Furthermore, in a high arousal state, these

effects may be facilitated as the relative weight of the construct that is activated by the cues increases in the impression formation because of the reduction of the total number of constructs that can be used by the perceivers. Therefore, the bias of the impression to the congruent valence with the previous manipulation is predicted to be most large in this condition.

The second purpose of this study was to examine the interactive effect of physiological arousal and processing of trait words upon the process of interpersonal perception described above. In the present study, trait words were presented to subjects at a subliminal level and they were asked to process them unconsciously to activate constructs relating to hostility or friendliness. This manipulation, that is a subliminal priming procedure, was derived from a study by Bargh & Pietromonaco (1982). The activation of constructs or the facilitation of the accessibility of constructs is assumed to be caused automatically and without mediation of attention or consciousness by the previous information processing. Thus, it is proposed that the processes of impression formation or judgement of social stilumi are influenced even if perceivers can not know what information they processed previously. The subliminal priming procedure developed by Bargh & Pietromonaco seems to be the most appropriate method to examine this formulation. Furthermore, an additional advantage of this method is to be able to rule out a demand effect explanation on the effect of the previous information processing. When subjects are asked to process some trait words consciously, it may be easy to infer the purpose of that manipulation and they may tend to behave in a congruent way with the manipulation. However, subjects are not able to know the purpose of the experiment in the subliminal priming procedure.

On the basis of the argument discussed above, the follwing hypotheses were examined:

1. When information of a target person is given in a high arousal state, a perceiver will become cognitively simpler in impression formation of the person.
2. When a perceiver previously processes trait words unconsciously in a high arousal state, individual difference of impression of the target person will be most small. On the other hand, when a perceiver previously processes irrelevant words unconsciously in a high arousal state, individual difference of the impression of the target person will be most large.
3. When a perceiver previously processes trait words unconsciously, the impression of the target person will be biased to the direction semantically congruent with the words. Furthermore, this biasing effect will be facilitated in a high arousal state.

Experiment 1

In Experiment 1, the author focused on the same trait category as the study of Bargh and Pietromonaco (1982), that is 'hostility'. Their findings have been remarkable. However, no replication of the findings has been reported in Japan with Japanease stimulus words. Thus, it seems to be appropriate to replicate and extend their results in

order to eliminate any alternative explanations. Hence, the method of this experimet was basically similar to that of Bargh and Pietromonaco (1982) except the addition of the manipulation of physiological arousal.

Methods

Overview

The experiment consisted of two periods: a motor-response task and a impression formation task. In the motor-response task period, subjects were presented either hostile words or neutral words in either high or low arousal state which was manipulated through the use of a cycling exercise. The heart rate (HR) was measured as an index of physiological arousal level. The motor-response task reqired the subjects to react as quickly as possible to stimuli (actually hostile or neutral words) that were presented on a CRT screen. After completing that, the subjects were asked to read a behavioral description of a stimulus person and to rate him on 16 trait adjective scales.

Subjects

Sixteen male and 16 female undergraduate students participated in the experiment voluntarily. They were randomly assigned to one of the four cells. The proportion of men to women in each cell was identical.

Apparatus

The experiment was conducted in a sound-attenuated and electronically shielded room with a one-way mirror. Recording of HR was performed with an 8 ch polygraph (Nihon-Kouden, RM-6000).

Materials

Stimulus words. Two lists of 12-words written in Japanease Kanji characters were prepared. The hostile word list was composed of words which were semantically related to hostility or anger, for example, *hostility, rage, aggression, retaliation.* On the other hand, the neutral word list was composed of words which were irrelevant to any affect, for example, *spirit, vacancy, understanding.* Each subject was presented one of these lists five times repeatedly, thus the total number of words which the subjects processed were 60. The word order on the lists were randomized in each trial.

Behavioral description. In the impression formation period, each subject was given a 8-sentence set which described a stimulus person engaging in somewhat hostile behavior. The content of these sentences was as follows: a male student had made an appointment to meet his friend at the station, but he did not come at the agreed upon time. The friend, who got tired of waiting after an hour, called him. The friend was in his home and said 'I am coming just now.' without any applogy.

Measure of cognitive complexity

The total cognitive complexity (TCC; Ikegami, 1983) was used as a measure of cognitive complexity in the present study. This measure indicates the degree of differentiation of each trait scale from the evaluative dimension, based on an assumption that a cognitively simple perceiver relys on only the evaluative dimension in impression forma-

tion. Thus, it was meant that the higher the TCC score is, the cognitively simpler the perceiver is. The technique for determinig TCC was identical to Ikegami (1983). First, the polarity of each scale item in the evaluative dimension was determined by a factor-analysis. Next, a score of '4' or '5' on each scale item was defined as a positive rating and a score of '1' or '2' on each scale item was defined as a negative rating in the evaluative dimension. Furthermore, a score of '3 (midpoint)' on each scale item was defined as a neutral rating. Then, TCC was determined as:

$$TCC = {}_kC_2 + {}_\ell C_2 + {}_mC_2$$

, where k was the number of positive rating, l was the number of negative rating, and m was the number of neutral rating.

Procedure

Each subject was seated in the experimental room and told that the purpose of the experiment was to examine the relationship between a physiological state and a simple motor task. Then, electrodes measuring HR were attached on each subject's left forearm and the rightside of the neck, and an electrode for the ground was attached on the rightside of the neck also. A 3 minute adaptation period was set up to habituate the subjects to the experimental environment and to stabilize their physiological state. Then, the baseline of HR was measured.

After that, subjects in the high arousal condition rode an exercise bicycle for 3 min with a speed of around 20km/hr. Subjects in the low arousal condition performed a task which required them to draw as many 30 cm straight lines with a ruler they could in a 3 min period. These tasks were followed by a 1 min rest period in which HR was measured in each cell. The subjects then conducted the motor-response task in which they were exposed to stimulus words unconsciously. At the center of the CRT screen a (+) was given for a fixation point on which subjects were asked to focus their gaze at all time. Each stimulus word was presented either right or left of the fixation point for 50 msec and a dummy stimuli (##) was presented for the same duration at the opposite side of the fixation point. Both stimulus words and the dummy stimuli were masked immediately by irrelevant digit patterns for 100 msec. The location of each word was randomized, and of the total of 60 trials, 30 words were presented on the right side and the other 30 were on the left side. The interval of each trial was 5 sec. The subjects were asked to answer at which side each word was presented by pressing one of two keys on a computer keyboard as quickly as they could. A pilot study had revealed that it was completely impossible to read and understand stimulus words in this condition, however subjects could decide which side the words were on to some degree.

The subjects were told that the experiment was over and asked to participate in what they believed was an unrelated experiment, which was actually the impression formation task. All subjects consented to participate. They were provided a set of 8 sentences describing a stimulus person's somewhat hostile behavior. Each sentence was

presented on a CRT screen for 8 sec and the subjects were asked to read it silently. After being presented all the sentences, they rated the impression of the stimulus person on 16 five-point SD scales.

The subjects were debriefed to explain the purpose of the experiment and to check that they were not aware of any manipulation. No evidence of demand effects or awareness were discovered.

Results

Check of arousal manipulation

An ANOVA (2 (Arousal) × 2 (Trait words)) on bpm of HR before the manipulation did not yield any significant main effects or interaction, lowest $p > .45$. This indecated there was no difference in arousal levels between conditions in the baseline. Then, ANOVA on changes of HR from the baseline revealed a significant main effect of arousal manipulation ($F(1/28) = 5.69$, $p < .05$). Neither a main effect of trait words nor an interaction was significant. Furthermore, Duncan's test revealed that HR increased more after cycling exercise than after the line drawing task ($p < .05$). These results showed that the manipulation elicited expected different arousal levels in the two task conditions.

Factor analysis of impression

To determine TCC scores, the polarity of each scale item in the evaluative dimension had to be decided. For this purpose, a principal-components factor analysis on all rating scales across all judgments was performed, with the varimax rotation of all factors with eigenvalues > 1.0 specified. The first factor accounted for 46.3% of the variance. It had the hightest loading on the likable, responsible, honest, warm, capable, and orderly scales and was interpreted as the evaluative factor. The polarity of each scale was determined by the positivity or negativity of the loading score of this factor. The second and third factors accounted for relatively small parts of variance, 10.3% and 7.2%.

Cognitive complexity

The means of TCC are shown in Fig. 1.. It indicates an interaction of arousal and

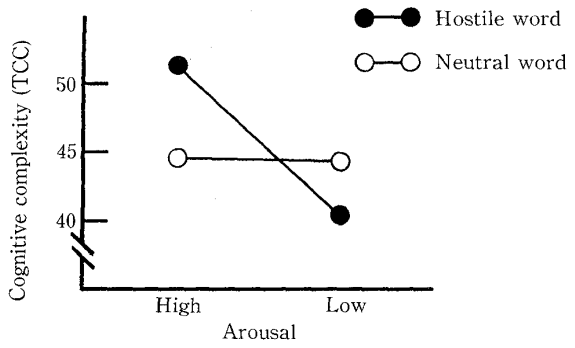

Fig. 1. Means of cognitive complexity. (Experiment I)

trait words. Namely, when subjects processed hostile words unconsciously the mean of

TCC in a high arousal condition was higher than in a low arousal condition, suggesting that the subjects became cognitively simpler in the high arousal state. On the other hand, when they processed neutral words, there was no difference in the means of TCC between two arousal conditions. This pattern seems to support the hypothesis. A two-way ANOVA (2(Arousal)×2(Trait words)) yielded no significant main effects and interaction (Arousal, $F(1/28)=1.90$, *n.s.*; Trait words, $F(1/28)=0.43$, *n.s.*; Interaction, $F(1/28)=1.54$, *n.s.*). To further clarify the relationship between arousal level and cognitive complexity, a correlation in changes of HR and TCC was examined. A highly significant positive correlation was found ($r(30)=.41$, $p<.01$), indicating that the higher the arousal level the simpler the impression became. Furthermore, as can be seen in Table 1, a regression analysis revealed that changes of HR was a significant predictor of TCC and neither processing of trait words nor an interaction determined TCC. In the regression analysis, processing of trait words was entered in the form of a dummy variable and the interaction was determined as:

$$\text{Interaction}=(X-\bar{X})\cdot(Y-\bar{Y})$$

, where X represented changes of HR and Y was processing of trait words, to decrease correlations between independent variables.

Table 1 Regression analysis on cognitive complexity

Arousal	Word processing	Interaction
.38*	.15	.03

Note : the level of significance.
* ; $p<.025$

These results showed that subjects became cognitively simpler in a high arousal state.

Impression

Since the first factor accounted for a large part of variance, scales measuring impression seemed to be highly correlated. Thus, to control for the possible redundancy in rating scales, and to create a unidimensional dependent variable which represents positivity-negativity of impressions, scales weghted by loadings of the evaluative factor were combined. This variable will be called the evaluative impression score from now. The high score in this variable means the negative impression. The averages of this score are shown in Table 2. The impressions seem to be more negative in hostile trait words conditions than in neutral trait words conditions, however, an ANOVA revealed no significant main effects and interaction (Arousal, $F(1/28)=1.31$, *n.s.*; Trait words, $F(1/28)=1.76$, *n.s.*; Interaction, $F(1/28)=0.06$, *n.s.*).

Table 2 Means and SDs of hostile impression score

	Arousal	
	High	Low
Word processing		
Hostile word	2.46 (0.27)a	2.71 (0.18)a
Neutral word	2.26 (0.95)b	2.43 (0.22)a

Notes: 1) Figures in parentheses indicate standard deviation.
2) There was no significant difference by F test between pairs with the same caracter.

Then, hypothesis 2 was examined. A Bertret's test revealed highly significant difference in the variance of the evaluative impression score ($\chi^2(3)=50.52$, $p<.001$). Furthermore, F test was performed in each combination of two cells and revealed that the variance in the cell of high arousal-neutral trait words was larger than in the other cells ($F(7/7)=12.42$, $p<.01$; $F(7/7)=27.37$, $p<.0001$; $F(7/7)=18.16$, $p<.001$), as can be seen in Table 2.

Relationship between complexity and impression

A significant positive correlation was found between TCC and the evaluative impression score ($r(30)=.37$, $p<.05$). This suggests the simpler a perceiver's cognitive strategy was the more negative the impression of the stimulus person became.

Discussion

A significant effect of arousal on TCC was not found in ANOVA. This is probably due to the large within-group variance of the arousal level. It is considered that there was a large individual difference in changes of arousal level even when subjects performed the same exercise. Researchers have to control this individual difference to examine roles of arousal in interpersonal perception. Therefore, a correlation between changes of HR and TCC was examined. A highly significant positive correlation was found in changes of HR and TCC, suggesting that the cognitive complexity decreased as the arousal level became higher. Moreover, changes of HR predicted the cognitive complexity significantly in the regression analysis. These data supported Hypothesis 1. Thus, it is concluded that physiological arousal impairs elaborate information processing and leads a perceiver to simpler and more heuristic processing where he/she uses fewer trait categories in impression formation.

In a high arousal state, the individual difference of the impression was expected to be larger when no contextual cues exist, and to be smaller with some cues (Hypothesis 2). The variance of evaluative impression scores in high arousal-neutral trait words condition was larger than in any other conditions. Since it can be assumed that

processing neutral words did not provide any contextual cues for subjects and no priming effects took place, this result can be considered to be consistent with the hypothesis. However, a significant difference was not found between the variance in high arousal-hostile words condition and one in each low arousal condition. In a previous study (Bargh & Pietromonaco, 1982), processing hostile trait words was shown to work as a contextual cue and to facilitate accessibility of negative trait categories in impression formation. If this is the case, the variance of impression sould be smaller when subjects process hostile words in a high arousal state, because subjects could use few activated trait categories in such a state. Nevertheless, the variance of the impression was not influenced by processing hostile words in this study. Thus, Hypothesis 2 was partially supported.

Moreover, the expected effects of unconscious processing of trait words on impression formation was not observed. The positivity or negativity of impression was not different in each condition regardless of manipulation of arousal and trait words processing. Therefore, this result did not support Hypothesis 3 and did not replicate the findings by Bargh & Pietromonaco (1982). These results may suggest that trait categories related to hostility were not activated by processing hostile words, resulting that neither the impression itself nor its variance was affected. However, before adopting this interpretation, at least two other possibilities have to be examined. First, a kind of ceiling effect might take place concerning the impression because of the characteristic of the behavioral description. In this study the stimulus person's behavior was somewhat hostile, therefore, it can be considered that the hostile trait category was somewhat activated by the behavioral description itself and the impression of the stimulus person became negative even when no other contextual cues existed. Thus, processing of hostile words might have only a little effect to activate the trait category.

Secondly, the lack of the effcts of trait word processing might be due to the characteristic of the trait category used in this study, that is hostility. Recently, it has been maintained that negative trait categories such as hostility might be less easily activated than positive categories (Ikegami, 1989). Furthermore, It was reported that the activation of negative trait categories does not necessarily lead impression to bias in the negative direction, whereas positive trait categories do (Gotlib & McCann, 1984). Althogh traditional network models (Wyer & Carlston, 1979; Bower, 1981) have assumed a symmetrical priming effect in both positive and negative evaluative trait categories, the positive-negative asymmetry in the priming effect have been found in a number of studies. Thus, it might be stated that the priming effects of the hostile category was relatively weak and not found in this study. To examine plausibility of this explanation, the priming effects of positive trait categories and that of negative trait categories sould be compared in a similar experiment design.

Experiment 2 was conducted to examine these explanations.

Experiment 2

The previous study produced results indicating effects of arousal on the mechanism

of impression formation. However, the expected effects of unconscious processing of trait words were not found. One of the possible causes of this result discussed above was a kind of ceiling effect which was caused by a hostile behavioral description. If this is the case, the priming effects should be found in the impression formation of a stimulus person described by more ambiguous or mixed information. To investigate this explanation, subjects were presented 4 positive, 4 negative, and 4 neutral behavioral descriptions of a stimulus person and asked to rate him/her in Experiment 2.

Another possible cause of failure to find the priming effects of trait words was attributed to the characteristics of the trait category used in the previous experiment; the trait category of hostility. Traditional network models (Wyer & Carlston, 1979; Bower, 1981) have assumed a symmetrical priming effect in both positive and negative evaluative trait categories. Some studies, however, reported positive-negative asymmetry in the priming effect. The affective priming effect has been found consistently in positive categories, whereas inconsistency has often been found in negative categories (e. g. Isen, 1984, 1985). To examine this difference in priming effects, both positive and negative trait categories should be manipulated in a similar experiment. Thus, the effects of processing not only of hostile words but also of friendly words were examined in this study.

Methods

Overview

The overall procedure was the same as in the previous study except for the following modifications. First, subjects were presented hostile, friendly, or neutral stimulus words through a tachistoscope (Takei, DP-6) instead of a CRT screen, to control more strictly the duration of the presentation. The subjects were required the same reaction-task as in Experiment 1. The duration of word presentation was 32msec, followed by a pattern masking for 100ms. A pilot study made it clear that subjects could not read and understand any words in this condition. Secondly, a set of 12 sentences that described various behaviors of a stimulus person were used instead of one hostile behavior in the impression formation task. The order of sentences were randomized between the subjects. Furthermore, the form of impression formation was changed to monopolar trait adjective scales. And finally, skin potential responce (SPR) instead of HR was measured as an index of physiological arousal through the same apparatus in the previous study. The electrodes measuring SPR were attached on each subject's palm and forearm of a nonprefered arm. A ground electrode was attached on the rightside of each subject's neck.

Subjects and design

Subjects were fifty four female undergraduate students who participated in the experiment voluntarily. The design was an overall 3×2 factorical design, with three trait words conditions (hostile, friendly, or neutral) and two arousal conditions (high or low) manipulated. The subjects were randomly assigned to one of the six cells.

Materials

Stimulus words. In each condition, three adjectives were used as stimulus words. Hostile words were *WAGAMAMANA (selfish), TSUMETAI (cold)*, and *IJIWARUNA (nasty)*. Friendly words were *YASASHII (gentle), OMOIYARINOARU (sympathetic)*, and *ATATAKAI (warm)*. Neutral words were *WAKAI (young), ISOGASHII (busy)*, and *FUTSUNO (average)*. Each subject was exposed to each word 30 times repeatedly, thus the total number of words which the subject processed was 90.

Behavioral description and impression rating. Subjects were given a set of 12 sentences of behaviors of a stimulus person, named 'Mr.Suzuki'. Four sentences described the person engaging in somewhat hostile behaviors (e.g. 'He complained to a shopgirl about her skill of wrapping'). Another 4 sentences described his somewhat friendly behaviors (e.g. 'He told a stranger the way to buy a ticket at a station'), and the remaining 4 described neutral behaviors (e.g. 'He got up at 7 a.m. and went out at 8 a.m.'). The subjects read the sentences and rated the stimulus person on 15 monopolar 5 point trait scales. Five of the trait scales were positive evaluative tone, another five were negative evaluative tone, and the remaining five were neutral.

Results

Check of arousal manipulation

Two-way ANOVAs (2 (Arousal) × 2 (Trait words)) on the frequency of SPR up to 0.5mV and the amplitude of SPR in pre-experiment rest period did not yield any significant main effects or interactions, lowest $p<.35$. Thus, there was no difference in arousal levels between conditions in the baseline. Then, changes of SPR from the baseline were examined and a significant main effect of arousal manipulation ($F(1/28)=3.47$, $p<.05$) was found in the frequency, whereas it was partially significant in the amplitude ($F(1/28)=2.89$, $p<.10$). Any other factors were not significant in both dependent variables. Duncan's test revealed that the frequency of SPR increased more after cycling exercise than after the line drawing task ($p<.05$). These results showed the manipulation of the arousal level was valid.

Factor analysis of impression

A principal component factor analysis was conducted in the same method as Experiment 1. Four factors with eigenvalues>1.0 were obtained. The first factor accounted for 39.5% of the variance and interpreted as the evaluative factor with hightest loading on the likable, responsible, honest, warm, gentle, and smart scales. The polarity of each scale was decided by the positivity or negativity of the loading score of this factor.

Cognitive complexity

Fig. 2. shows the averages of TCC which was determined by the same formula in Experiment 1. A two-way ANOVA (2(Arousal) × 3(Trait words)) yielded a significant main effect of arousal ($F(1/48)=4.72$, $p<.05$). Neither a main effect of trait words nor an interaction was significant ($p>.45$). Moreover, Duncan' test revealed that the

cognitive complexity decreased significantly in high arousal conditions ($p<.05$). These results were consist with that in Experiment 1.

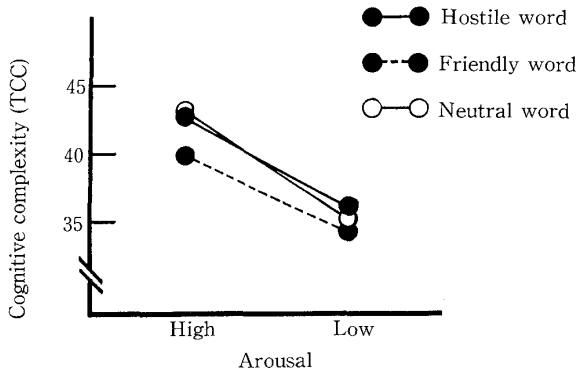

Fig.2. Means of cognitive complexity. (Experiment II)

Impression

The evaluative impression score was determined by the same method in Experiment 1, but unlike in Experiment 1 the high score of this variable represented the positive evaluation. The evaluative impression scores were highest in friendly words conditions, and lowest in hostile word conditions, as can be seen in Table 3. These results seem to support the hypothesis, however an ANOVA yielded no significant effects ($p>.40$).

No significant differences were found also in the variances of evaluative impression score.

Table 3 Means of impression score

	Word processing		
	Hostile word	Neutral word	Friendly word
Arousal			
High	6.79	7.30	7.95
Low	6.65	6.62	7.33

Note: Larger figures mean more positive impressions.

Relationship between cognitive complexity and impression

Fig. 3. shows the relationship of TCC and the evaluative impression score. A curved linear relationship can be seen, indicating that the evaluative impression score diverges as TCC becames higher. Namely, it is suggested that the impression of the stimulus person became extreme as the subjects became cognitively simpler.

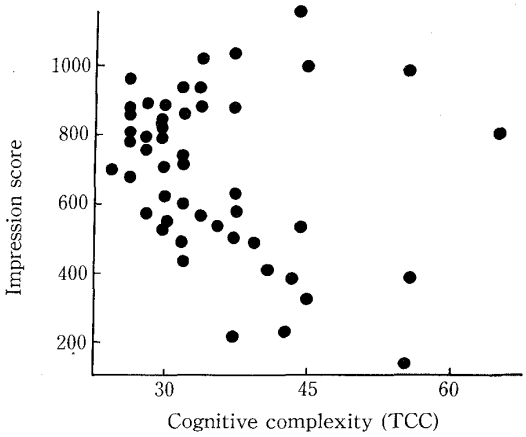

Fig.3. Relationship between cognitive complexity and impression.

Discussion

Clearer evidence for Hypothesis 1 was obtained in this experiment. As predicted, subjects became cognitively simpler in impression formation in a high arousal state, regardless of trait words processed previously.

Nevertheless, no distinct priming effects of the processing of trait words were found as well as in Experiment 1. Although the behavioral description presented in this experiment was more ambiguous and mixed than that in Experiment 1, unconscious processing of neither friendly trait words nor hostile trait words affcted impressions. Because of this lack of effect of trait word processing, the interactive effect of physiological arousal and activation of trait categories on impression formation could not be examined.

General Discussion

An important role of physiological arousal in interpersonal perception was shown in the present study. The two experiments have made it clear that high arousal makes percievers' cognition simpler and causes the impression of others to be more extreme. These effects of physiological arousal can be attributed to its influence on processing or attentional resource. In a high arousal level individual's processing resource might be reduced. Thus, simpler and less effortful processing strategies might be selected automatically.

By assuming these effects of arousal on processing resource, we can explain various aspects of the influence of arousal on interpersonal perception in the same theoretical frame. Arousal is affected by various endogenious or exogenious factors. Most emotions are usually accompanied by an escalation of arousal. Environmental factors such as temparature or noise vary arousal level. Furthermore, people have wide individual differences in every-day arousal levels (Cacioppo, Uchino, Crites, Snydersmith, Smith, Berntson, & Lang, 1992). These many factors might affect the mechanism of interpersonal peception indirectly mediated by changes of arousal level. Therefore, the factor of physiological arousal sould be taken into account for constructing models of interpersonal perception in future research.

The second purpose of this study was to examine interactive effects of physiological arousal and activation of trait categories which would be elicited by processing trait words, upon impression formation. However, the priming effects of trait words on impression could not be found in the two experiments. The possibility that this failure of priming effects was due to the characteristics either of behavioral description or trait words used in the priming tasks, was ruled out by the results of Experiment 2. Thus, it might be plausible to consider that the priming effects did not take place, because the accessibility of the trait categories was not facilitated by the unconscious processing of trait words. The procedure of the subliminal priming is somewhat delicate and its validity might be dependent highly on the setting of the exposure time of the trait words. Indeed, in the previous study subjects were exposed to trait words for a longer time (100ms) than in this study (50ms in Experiment 1, 32ms in Experiment 2). It can be condidered that the presentation times of the trait words in this study were too short to facilitate the accessibility of the trait categories. Thus, replication tests should be conducted in various experimental conditions concerning this priming procedure.

For those results one can consider another interpretation, which maintains that the facilitation of accessibility in a trait category does not necessarily cause a bias of impression. Even if the subliminal processing of trait words facilitated the accessibility of trait categories, that might not influence impression formation directly. Some unfound variables might mediate in this process and influence output of impression. To examine this mechanism, the accessibility has to be measured directly. Since it was not measured in the present study, it is impossible to decide which explanation is correct. The accessibility is considered to be measured by reaction time, word completing task, or some components of event related potential (ERP). These measures should be taken into account in future research.

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