Effects of stimulus- or response-oriented training on psychophysiological responses and the propositional structure of imagery

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This research was performed to test Lang's theory (1979a) about psychophysiological changes accompanied with the emotional imagery. The purposes were to reconfirm his observation, and to investigate further the effects of response- and stimulus-oriented trainings on psychophysiological responses to various propositional structures of imagery when subjects were asked to imagine freely instead of using given imagery scripts. Twenty subjects were divided into stimulus and response groups. After a relaxation training, the stimulus and the response groups were given the stimulus and the response-oriented trainings, respectively. All subjects then, took, the script imagery test and the free imagery test. Measures in IBI, respiration, EMG, and temperature during neutral, fear, and action scenes in the test battery were analysed. The results generally support Lang's hypothesis, that the response-oriented imagery is more effective in eliciting psychophysiological changes than the stimulus-oriented imagery. For the free imagery condition, no physiological differences between two oriented groups were apparent in all scenes. The results however, suggested, that the propositional structure of imagery were altered by the proposition oriented training.

Key words: imagery, Lang's theory, proposition oriented training, physiological responses, propositional structure of imagery.

There are some studies observing that the emotional imagery can evoke certain kinds of psychophysiological responses. It was found that a fearful or threatening imagery produced significantly increased in heart rate and/or skin conductance than neutral or relaxing imagery (Boulougouris, Rabavilas, & Stefanis, 1977; Grossberg & Wilson, 1968; McCance & Tennarella, 1980; Markes & Huson, 1973; Van Egeren, Feather, & Hein, 1971). Furthermore, Van Egeren et al. (1971) found that threatening imagery was associated with peripheral vasoconstriction and respiratory acceleration. However, the definition or the theory of imagery were not clearly formed in the above studies.

The first clearly stated theory was “a bio-informational theory of emotional imagery” proposed by Lang in 1979. He described that physiological responses during emotional imagery are based on the structure of the imagery. He and his associates have been conducting various experiments to verify his hypothesis since (Kozak, McLean, Miller, & Lang, 1983; Lang, 1979b; Lang, Kozak, Miller, Levin, & McLean, 1980; Lang, Levin, Miller, & Kozak, 1983; Lang, Miller, & Levin, 1983). The present study also tested the validity of his theory by investigating relationships between psychophysiological responses and the structure of the emotional imagery.

Lang (1979a) hypothesized that the imagery is a set of propositions and the propositions are organized into networks. The propositions are divided into stimulus and response propositions. The former propositions are descriptors of context, events, and agents that are to be perceived in the imagery. The latter propositions refer to things that the imager is doing in the scene. It is postulated that psychophysiological responses during imagery are determined by the response propositions included in the structure of the
imagery.

Lang also proposed that a script controls image content. A script is made up of sentences describing the events to be imagined. And the script contents are divided into stimulus and response propositions. He, then hypothesized that the propositional structure of the script can control that of the imagery. In other words, he assumed that psychophysiological responses are greater when a subject imagines scripts including response propositions than stimulus propositions. Along with this context, Lang developed two types of training programs, the response-and the stimulus-oriented training, designed to make both structures of the imagery and the script homologous. A group which received response scripts after response-oriented training was compared to a group which received stimulus-oriented training and stimulus scripts. The results supported the hypothesis: Response-oriented subjects showed greater amount of physiological activities during imagery than stimulus-oriented subjects.

Some applications of this theory and the training procedure to clinical contexts appears to be promising, however, it would be necessary to examine the effects of oriented trainings on the physiological pattern and the structure of imagery when subjects imagine without scripts before proceeding to such clinical applications. Therefore, in the present research, we tried to replicate Lang's observations first, then we investigated the effect of response- or stimulus-oriented training on psychophysiological responses and the propositional structure of imagery when subjects freely imagine instead of being given imagery scripts.

Since the specific purpose of this study is not to investigate the effects of propositional oriented trainings, but the effects of the difference between response-oriented and stimulus-oriented trainings, the untrained control group was not included in the present study.

**Method**

**Subjects**

The subjects were 20 Japanese undergraduate volunteers of Sophia University who were from 19 to 22 years in age (mean = 20.6). Fourteen female and six male subjects were randomly assigned to one of two sex-balanced groups. One was the stimulus group which received the stimulus-oriented training, the other was the response group given the response-oriented training.

**Apparatus**

Inter-heartbeat-interval (IBI), respiration, frontalis EMG, and peripheral skin temperature were recorded. ECG was measured using the standard lead II derivation. The electrodes were 5 × 3 cm plates of stainless steel strapped to the arm and legs with rubber bands. IBI was recorded using a home made IBI timer\(^1\) with a precision down to 1 ms. The output from the timer was fed into a NEC PC-8001 personal computer system and the processed IBI data were stored on a magnetic disk. Respiration was measured by means of a strain gauge transducer mounted on a belt (Nihon Koden TR-601T) which was strapped around the chest. The output of the transducer was recorded on a rectiorder (Nihon Koden). EMG was recorded from the frontalis muscle group by a pair of Ag/AgCl surface electrodes, was amplified and integrated by BF-300 model (OG Giken), and the results were stored on magnetic disks of the PC-8001 after the A/D conversion. The peripheral skin\(^2\) This apparatus was constructed by Toshiya Iwahashi, Sophia University. We thank him for his help.

\(^2\) The Autogen 1000b measures temperature based on the Fahrenheit scale, therefore, we adopted the expression (°F) and analysed the temperature on the basis of the °F scale. The conversion formula from °F to °C is the following: °C = (°F − 32)/1.8.
temperature was measured by Autogen 1000b (Autogenic System). A 5-mm-diameter disk thermistor of this device was attached to a fingertip of the middle finger of the right hand using a piece of surgical tape. As in the EMG recording, the data was stored on the disk.

Procedure

All subjects were first examined by the Sheehan revision (Sheehan, 1967a, b) of the Betts’ Questionnaire Upon Mental Imagery (QMI) for assessment of the vividness of image on the seven-point scale. The subjects were then seated in a reclining chair in a dimly-lit room in which they were given a progressive relaxation training (for about 20 min). This was done to reduce excessive background physiological noises and variability. After the relaxation training, the stimulus-oriented training was performed on the subjects of the stimulus group, whereas the subjects of the response group received the response-oriented training. The subjects were asked to imagine pre-recorded image scripts for training with their eyes closed and to report what they had imagined. The trainer differentially and systematically augmented the effects of the statements, that is, for the stimulus group statements involved with stimulus propositions were verbally reinforced but response descriptions were ignored. On the other hand, for the response group response descriptions were reinforced but stimulus statements were ignored. Each subject of both groups was given three imagery scripts and was trained two times per script.

After the training, all subjects took the script imagery test. Table 1 shows ten scenes which subjects were asked to imagine. For the response group the action and fear scenes contained stimulus plus response propositions. For the stimulus group these six as well as neutral scenes were constructed by only stimulus propositions. In addition, each script of action and fear scenes for the response group included one reference to each of the five physiological systems: cardiovascular, skeletal muscle, sweat gland, eye movement, and respiratory. Table 2 shows a sample action script. The response propositions are underlined. The scripts were translated from Lang’s original (Lang et al., 1980; Lang et al., 1983) with some revisions. We also used some scripts which we constructed by ourselves. The first scene for all subjects was neutral and was excluded from analysis, because we knew from the pilot experiment that physiological responses in the first scene had always excessively large variability. All scripts were pre-recorded on a cassette recorder and were presented through a speaker.

One script was used in each trial which was divided into five time periods: a 20 s rest period, a 50 s listen period during which a pre-recorded script was presented and the subject imagined it, a 20 s image period in which the subject continued to imagine the scene after the termination of the script, a 20 s recover period after stopping imagery, and a final rating

### Table 1

Contents of script for neutral, fear, and action scenes

<table>
<thead>
<tr>
<th>Neutral scenes (Trials 1, 2, 6, 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lying on a sandy beach</td>
</tr>
<tr>
<td>2. Sitting in the living room</td>
</tr>
<tr>
<td>3. Waiting at a bus stop</td>
</tr>
<tr>
<td>4. Sitting in a lawn chair</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fear scenes (Trials 4, 7, 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Taking a blood sample</td>
</tr>
<tr>
<td>2. Snake in the water</td>
</tr>
<tr>
<td>3. Speech contest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Action scenes (Trials 3, 5, 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Flying a kite</td>
</tr>
<tr>
<td>2. Playing ping pong</td>
</tr>
<tr>
<td>3. Riding a bicycle</td>
</tr>
</tbody>
</table>

We greatly appreciate his kindness to send us many literatures including appendices in which the imagery scripts and the procedure are detailed.
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Table 2
A sample script for action scene

Stimulus propositions only

You are flying a kite on the beach on a bright sunny day. The red kite shows clearly against the cloudless blue sky and whips quickly up and down in spirals with the wind. The sun glares at you from behind the kite and makes the white sandy shore sparkle with reflection. The long, white tail dances from side to side beneath the soaring red diamond. A strong gust of wind catches the kite, sending it higher and higher into the sky.

あなたはよく晴れた夏の日の海岸で風を上げています。赤い風は雲ひとつない青空の中にくっきりと見えています。そして、風とともに上がり下がったりしています。風のうしろで太陽がさびらして輝いています。太陽の光を反射して、白い砂浜はきらきらと光っています。高く昇った赤いダイヤモンドの形をした風の下で、長く白い風の脚が左右に踊っています。突然吹いてきた風がその風を空の上へ運んで行きます。

Stimulus and response propositions

You breathe fast as you run along the beach flying a kite. Your eyes trace its path as it whips up and down in spirals with the wind. The sun glares into your eyes from behind the kite, and you tense the muscles in your forehead and around your eyes to block out the sunlight. You perspire freely in the warm sun. Your heart races while you run along the sand, leading the kite, whose long white tail dances beneath the soaring red diamond.

あなたは海岸沿って走り、呼吸が速くなっています。太陽の光が見えます。あなたは目で追い、風のうしろで太陽の光を直接見えます。あなたは目の光をさえぎろうとする、額の筋肉を緊張させます。汗は太陽をうけて汗をかきます。あなたは風を引っぱって砂浜に沿って走り、心臓はとても速くなっています。高く昇った赤いダイヤモンドの形をした風の下で、長く白い風の脚が踊っています。

Table 3
Contents of neutral, fear, and action scenes which were used in the free imagery test

<table>
<thead>
<tr>
<th>Trial</th>
<th>Scene Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td>You are jogging.</td>
</tr>
<tr>
<td>(Action)</td>
<td>ジョギングをしている</td>
</tr>
<tr>
<td>Trial 2</td>
<td>You are sleeping on the lawn.</td>
</tr>
<tr>
<td>(Neutral)</td>
<td>芝生の上で寝ぼけている</td>
</tr>
<tr>
<td>Trial 3</td>
<td>A big spider is crawling beside your pillow.</td>
</tr>
<tr>
<td>(Fear)</td>
<td>眠っている枕のわきを大きなクモがあがっている</td>
</tr>
<tr>
<td>Trial 4</td>
<td>You are playing at snowballing.</td>
</tr>
<tr>
<td>(Action)</td>
<td>雪合戦をしている</td>
</tr>
<tr>
<td>Trial 5</td>
<td>You meet with a strong earthquake in a high building.</td>
</tr>
<tr>
<td>(Fear)</td>
<td>高層ビルで大きな地震にあう</td>
</tr>
<tr>
<td>Trial 6</td>
<td>You are listening to a record.</td>
</tr>
<tr>
<td>(Neutral)</td>
<td>レコードを聞いている</td>
</tr>
</tbody>
</table>

period in which the subject was asked to make ratings of arousal, vividness and compliance to the scene imagined. In this last period, no time limit was imposed.

Each subject then participated in the free imagery test. Both groups were presented with the same sentence describing a certain situation (see Table 3), and the subjects were asked to freely imagine the scene. They were presented with six scenes: two neutral, two fear, and two action scenes. All scenes included only stimulus propositions.

Each scene was presented according to the following format: a 20 s rest period, 40 s during which one of the scenes was presented via tape and the subject freely imagine it (image period), a 20 s recover period, and a rating period. In the rating period subjects were required to complete a questionnaire list, which contained ten items: Five items were related to stimulus descriptions, the others were related to response ones. Subjects were asked to mark the items which were corresponding to what they imagined.

After the experiment a monetary re-
ward was given to the subject. The experiment took about 90 min.

Data Reduction

Physiological responses were measured during all periods except the rating period in both imagery tests. Data reduction was firstly carried out in each subject. For IBI, skin temperature, and frontalis EMG, medians were computed in each period. Then, the change scores were created using these median values by subtracting the rest period values from the listen (this period was not in the free imagery test), image, and recover period scores. The waveform of the respiration records from the recticoder were measured manually and the cycle/min units in each period were derived from the raw scores. Finally change scores were likewise computed for each period. These change scores were then averaged over three trials (two trials for the free imagery) of each neutral, fear, and action scenes for each period. Finally, the average change score of each group was computed for each period and for each scene. The above processing was mostly done by the computer except for the respiration.

Results

Base Line Levels

To examine physiological base line level differences between the stimulus and the response groups, t-tests were performed comparing the values during the rest period in the second script-imagery trial. There was no significant differences for all physiological responses. Therefore, base line level difference was not taken into account in the subsequent analysis.

Script Imagery Test

Physiological responses. The changes of four physiological responses to the different experimental variables are presented in Fig. 1. The L, I, and R on the

![Fig. 1. Mean changes in IBI, respiration, frontalis EMG, and fingertip temperature from the preceding rest period to listen (L), image (I), and recover (R) periods. Results are shown for response and stimulus groups during script imagery.](image-url)
horizontal axis indicate the listen, image, and recover periods, respectively. As regards IBI, a group × period × subject analysis of variance for each script scene was performed. The analysis of the neutral scene yielded no significant difference between the two groups. In the fear scene, the change score of the response group was slightly greater than that of the stimulus group ($F(1/18)=4.13$, $p<.10$). For the action scene, however, the patterns of both groups were similar and no significant difference was apparent. To examine the difference among three scenes, a group × scene × subject analysis of variance was applied. The analysis indicated that the main effect for scene was significant during the listen and image periods ($F(2/36)=5.70$, $p<.01$; $F(2/36)=5.39$, $p<.01$ respectively).

Analysis of variance for respiration changes indicated no significant group difference for the neutral scene. However, the cycle/min score of respiration for the response group was significantly greater than that of the stimulus group during the fear ($F(1/18)=6.98$, $p<.025$) and the action scene ($F(1/18)=9.28$, $p<.01$). As in IBI, the main effect for scene was significant in the listen ($F(1/18)=9.17$, $p<.01$) and image periods ($F(1/18)=9.57$, $p<.01$).

Also, as in IBI and respiration, for the neutral scene there was no significant difference between groups in frontal EMG. Change scores of the responses group were somewhat greater than that of the stimulus group during the fear and action scenes, however, the difference was not significant. On the other hand, it was found that the change score of the neutral scene was significantly less than that of other arousal scenes through listen, image, and recover periods ($F(2/36)=3.96$, $p<.05$; $F(2/36)=5.36$, $p<.01$; $F(2/36)=4.68$, $p<.025$ respectively).

Regarding peripheral temperature, no difference between groups was apparent for the neutral scene. Statistical analysis of the fear and action scenes indicated no significant difference between groups. However, the temperature score of the response group was lower than the stimulus group. In addition, an analysis of variance yielded that the main effect for scene was significant in the image period ($F(1/18)=4.76$, $p<.05$), that is, temperature of both groups increased in the neutral scene, whereas the temperature for the response group decreased in the fear and action scenes.

Self report measures. Compliance score was rated from 1 to 5, which represented the degree of the similarity between the images subjects had created and those described in the scripts. The mean rated scores of both groups were 4 over all scenes, which suggest that the script provided the major source of the imagery of the scenes.

Vividness and arousal ratings for all script scenes were averaged in each group. The vividness was assessed by the same rating scores used for QMI. The average vividness rating scores for the response group was 3.1 to the neutral scene, 2.8 to the fear scene, and 2.9 to the action scene. For the stimulus group the rating scores were 3.1, 3.0, and 2.7 respectively. Analyses of both groups yielded no significant differences between groups, nor among scenes. With regard to the arousal ratings, subjects were asked to rate the arousal on 5-point scale (1=completely relaxed, 5=completely aroused). The average arousal rating scores for the response group was 2.3 to the neutral scene, 3.8 to the fear scene, and 3.7 to the action scene. For the stimulus group the arousal ratings scores were 2.1, 3.2, and 2.6 respectively. An analysis of variance (group × scene × subject) yielded that the response group gave significantly higher

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4 Room temperature ranged from 73.4 °F (23 °C) to 77.0 °F (25 °C) throughout the period of three weeks in which the experiments were carried out.
arousal scores than the stimulus group ($F(1/18)=15.47$, $p<.005$). In addition, group $\times$ scene interaction showed a statistical significance ($F(2/36)=5.53$, $p<.01$). Furthermore, an analysis indicated that there are highly significant differences among the scenes both in the response group ($F(2/18)=69.54$, $p<.005$) and in the stimulus group ($F(2/18)=10.77$, $p<.005$).

**Free Imagery Test**

**Physiological responses.** The patterns of IBI, respiration, frontalis EMG, and peripheral temperature over image and recover periods are illustrated in Fig. 2. A series of analysis of variance (group $\times$ period $\times$ subject) for each scene was performed on each physiological response, in order to assess the difference between groups. It was found that there are no significant differences for all physiological measures in all scenes. A group $\times$ scene $\times$ subject analysis of variance was also performed for the difference among scenes. It indicated that in image periods the main effects for scenes were significant for IBI ($F(2/36)=4.63$, $p<.025$), respiration ($F(2/36)=11.24$, $p<.005$), and EMG ($F(2/36)=5.39$, $p<.01$). In addition, a group $\times$ scene interaction for respiration was significant ($F(2/36)=7.69$, $p<.005$). For temperature, however, the analysis revealed no main effect for scenes.

**Questionnaire.** A chi-square test was performed on the items marked in each group. In the stimulus group, the sum of the stimulus items marked in all scenes was significantly larger than that of the response items ($\chi^2(1, N=299)=28.93$, $p<.005$). Furthermore, the analysis for each scene indicated that subjects of the stimulus group significantly marked the stimulus items more than the response items in the neutral scene ($\chi^2(1, N=89)=29.23$, $p<.005$) and the fear scene ($\chi^2(1, N=112)=7.0$, $p<.01$), however, there was no difference between both items in the action scene.

The items marked in the response group
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were analysed in the same manner as above. No difference between the stimulus and response groups was found for the sum of all scenes and the frequency of each scene.

QMI

The total score of QMI was computed for each subject, and then averaged separately for the response and the stimulus groups. The mean total scores were 102.6 (SD=19.28) for the response group and 113.8 (SD=25.85) for the stimulus group. A t-test revealed no difference between the groups (t(18)=1.04, p>.05).

Finally, for each group coefficients of the correlation were computed between the total score of QMI and each physiological change score because the standard deviation of QMI score within each group was large. The coefficients were calculated in each period for each scene.

In regard to script imagery scenes, for the response group the correlations between IBI and the QMI score were comparatively high in the listen period of the neutral scene (r=.572, p<.10) and in both the listen and image periods of the action scene (r=.678, p<.05; r=.607, p<.10 respectively). The coefficients computed between temperature and QMI were also high in the listen period (r=-.570, p<.10) and the recover period (r=-.549, p<.10) of the fear scene. Although respiration changes and QMI were related in the listen period of the neutral scene (r=-.609, p<.10), no such association was observed between EMG and QMI. In addition, the correlations in the free imagery condition were obtained for the response groups. The coefficient obtained between IBI and QMI was considerably high in the image period of the neutral scene (r=.841, p<.01). Furthermore, respiration and QMI was associated in the image period of the neutral scene (r=-.553, p<.10).

For the stimulus group, however, EMG and QMI were only significantly associated in the image period of the fear scene during free imagery test (r=-.663, p<.05). No such association was observed between other physiological changes and QMI.

Discussion

There are some differences in the physiological parameters between the experiments conducted by Lang group and the present one. Lang and his associates used heart rate, respiration, activity in the frontalis and semispinalis capitus muscles, skin conductance, and electro-oculogram as psychophysiological indices, whereas in the present study, inter-beat-interval (IBI) as heart rate, respiration, frontalis EMG, and peripheral skin temperature were measured. The frontalis EMG was only measured as activity in muscle because it was considered to be an index of general arousal (Stoyva & Budzynski, 1974; Passchier & Helm-Hylkema, 1981) including a general tension level. Moreover, it was considered that the frontalis muscle activity reflects substantial eye movement activity (Grossberg & Wilson, 1968), so that the electro-oculogram was not measured in the present study.

On the other hand, skin conductance was used to measure sympathetic activation in Lang’s studies. We measured the peripheral skin temperature, instead, but these two indices should be equally effective in measuring sympathetic activation, because the peripheral skin temperature is also regulated by the sympathetic fibers of the autonomic nervous system. Skin temperature is dependent mainly on the flow of blood through the arteries and arterioles of skin (King & Montgomery, 1980). It is generally accepted that the sympathetic nervous system is responsible for both the vasomotor innervation of the skin and the innervation of sweat glands related to the electrodermal activity, and that the para-
sympathetic nervous system has virtually no influence in these function (Barcroft, 1960, 1963; Uvnäs, 1961, 1966; Venables & Christie, 1973). It was then assumed that during imagery response-oriented subjects showed more decrease of the peripheral skin temperature than stimulus-oriented ones.

There is a problem associated with the choice of peripheral skin temperature as an index of the sympathetic activation, which is the lag between the initial change in circulation and the temperature recording. However, this problem is minimized in finger recordings where blood flow is almost exclusively to the skin (Ackner, 1956; Plutchik, 1956).

The present results generally support Lang's hypothesis, that the response-oriented imagery is more effective in eliciting psychophysiological changes than the stimulus-oriented imagery. The response group showed significantly greater changes in IBI and respiration to action and fear scenes than the stimulus group, except for the IBI to the action scenes. Greater increase in frontalis EMG and greater decrease in temperature to the arousal scenes are associated with the response-oriented imagery, although it failed to reach to a significant level. Furthermore, in the script imagery, physiological responses in the neutral scenes were less than that in the other arousal scenes. This result is consistent with Lang's observation. With respect to self-rated measures, the present results indicated that vividness ratings were not different for the two groups and three scenes. This result disagrees Lang's observation (Lang, 1979a; Lang et al., 1980) in which neutral scenes were imaged more vividly than either fear or action scenes. Weerts and Lang (1978) suggested that the level of anxiety affected vividness ratings to scenes. Should it be true, the subject's anxiety level such as the state anxiety may affect his or her ratings in our experiment also because the subject was in an unfamiliar experimental situation. On the other hand, we found that subjects who received response scripts produced greater arousal ratings during imagery than subjects with stimulus scripts. In addition, arousal scenes, i.e. fear and action scenes, received higher ratings than the neutral scenes. These results again agree with Lang's.

As to the results of the free imagery, we found that there are no differences between two oriented groups for all physiological measures in all scenes. The proposition oriented training in the present study was performed in only one session including three scenes. However, it is possible that physiological differences between oriented groups might become more manifested if the subjects undergo more trainings. The lack of differences may also be due to the nature of the scene imagined. It was found from interviews after experiment that some subjects consider the spider non-fearful, and that most of subjects imagined the quiet music during the scene listening to the record, but some did the loud rhythmical one such as the rock music. The results from the questionnaire, however, showed that in the stimulus group which received stimulus-oriented training, the number of the selected stimulus items were significantly larger than the response items. No such difference was apparent for the response group. The results suggest that the structure of imagery are altered by the propositional orientation.

Finally, the present results showed that most of the significant correlations between physiological changes and QMI scores were found in the group received response-oriented training. Moreover, the correlations were about the same across the contents of the scene. The results suggest that the response-oriented training intensifies a tendency to change physiological responses toward a certain fixed direction during imagery depending upon the individual ability to imagine
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