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Attention Shift to Global and Local Level of a Form Depends upon Stimulus Set

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Two experiments examined the effect of stimulus set, feature or dimension (Garner, 1978), on modes of attention shift to global and local level of a compound stimulus. In Experiment 1, an analysis of inter-trial transitions of attended levels showed a level shift effect in the feature set compared to no such effect in the dimension set. In Experiment 2, attention shift between levels of the compound stimulus was forced by presenting identities of the two levels in sequence. Attention shift to the local was easier in the feature set than that to the global. In the dimension set, however, shift to the global was easier than shift to the local, and giving attention to either level appeared to be fast and stable. These results imply global precedence (Navon, 1977) is not a general rule and stimulus structure should be considered as an important factor in the study of precedence. The level readiness effect (Ward, 1982) and the stages of spatial attention shift (Posner, 1988) were considered in the general discussion.

Keywords: stimulus set, feature, dimension, attention shift, compound stimulus, precedence

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A form has a number of features: Some local features are mutually exclusive parts like every line of a letter and others are global features like configuration, symmetry and vertex. A global feature can thus be quickly distinguished from a local feature. Which feature is, then, more important in form perception? Gestalt psychologists proposed that perception of the whole precedes and guides that of parts (e.g., Arnheim, 1986). However, many researchers following constructivism have tried to explain perception of the whole by perception of its parts (e.g., Neisser, 1967). These two approaches seem to be in conflict at least with respect to the time course of perception.

Navon (1977) used compound stimuli to explore which feature, global or local, would be processed earlier than the other. Global letters were composed of local letters, and they could be congruent or incongruent with each other. For example, a global 'H' or 'S' was made by arranging either many local 'H's or many local 'S's (see Figure 1 for similar examples). While incongruent global identities slowed reaction times when judging local identities of compound letters (i.e., a kind of Stroop interference), local identities had no such effect when judging global identities. Navon argued for a principle of global precedence that global processing always precedes local processing.

Subsequent studies have showed that global precedence is constrained by many perceptual conditions like stimulus size, sparsity of local letters, stimulus quality, etc (e.g., Hoffman, 1980; Kinchla, Solis Macias, & Hoffman, 1983; Martin, 1979; Park & Kim, 1991, for a review). The mechanism of global precedence, however, has not been clearly revealed. Paquet and Merikle (1988) proposed a hypothesis that whereas global features are preattentively processed, local features are processed by focal attention. Navon (1991) reported a study that the advantage of global processing was not diminished by an enhanced local processing, thus indicating that global precedence is a principle based on perceptual mechanism.

However, other studies considered global precedence as an attentional phenomenon. Miller (1981) suggested on the basis of an analysis of a cumulative probability density function of detection time that global precedence arose from the tendency that people perceived the whole object as a unit by giving more attention to a global than to a local feature. Kim (1990) and Park (1986) found that global influence became reduced in local judgment, as a presentation probability of global information to be ignored increased. They concluded that global processing became automatized in proportion to its presentation probability, requiring less attention, so global information of high probability became rather easily ignored (Logan & Zbrodoff, 1979). Ward (1982) found a level-readiness effect "whereby processing was faster at a given level if previous processing had been at that level." (p.562) These studies indicate that global precedence is not based on a perceptual mechanism, and global precedence or its opposite, local precedence, can be modulated by attention. Unfortunately, however, this interpretation has not been subject to any direct manipulation of attention.

In order to argue for the attentional mechanism underlying global or local precedence, it is necessary to explicate how attention is involved in processing of global or local features of compound stimulus. Stoffer (1993) manipulated cue validity of the global and the local level and measured reaction time with varying stimulus-onset-asynchrony (SOAs) between pre-cue and compound stimulus. He concluded "attentional zooming to the local level needs more time than does zooming to the global level" (p. 14). Likewise, Robertson, Egly, Lamb, and Kerth (1993) observed validity effects of both global and local cues. However, the global identities and the local identities employed in these studies were from different stimulus sets, so precedence could not be tested in the way Navon (1977) did using congruent and incongruent identities between the two levels of compound stimuli. Congruity of compound stimuli needs to be manipulated in order to make the global and the local level compete and to reveal the relative superiority of the one to the other. Therefore, we introduce congruity in studying attention shift to the global or the local level. Because attention and perception are inseparably related, it would be reasonable to assume that the level more quickly attended to should be the one earlier processed. To explore which level can be quickly attended to, it is necessary to have participants process the information of a level unpredictably indicated. Another aspect of attentional processing, though interesting, has not been investigated yet. It is how attention does shift from the global to the local level or from the local to the global level in a compound stimulus. For this, it may be necessary to have participants shift their attention from the global to the local level or in the opposite direction.

Concerning global and/or local precedence, we cannot overemphasize the importance of stimulus property. As earlier noted, precedence was constrained by a variety of stimulus properties. Another stimulus property not mentioned yet regards the relationship between the global and the local level. For example, Pomerantz (1983) distinguished a P type from a N type among compound stimuli. The P (place) type is a compound stimulus where local stimuli hold their places without changing a global configuration. Most stimuli used in the precedence research belong to this type, as in the stimuli of Figure 1. The N (nature) type is the one where global configuration is greatly changed by the nature of local stimuli. For this type, Pomerantz employed an arrow and a triangle as global levels, and diagonals and right angles as local levels. This classification is logical and appealing from the construction of a single compound stimulus. The task given to participants, however, was mostly to discriminate either the two global identities or the two local identities instead of discriminating between the global and the local. We argue that Pomerantz's classification could not be applied to his task, which might be the reason he did not get a clear result with the N type.

A given stimulus set by which all the stimuli are generated and related has been found a significant factor on performance with card sorting tasks, as amply demonstrated by Garner and his colleagues (Garner, 1974). Garner (1978) distinguished between a feature set and a dimension set. Two stimuli in a feature set can be discriminated by the presence or absence of a particular feature. For example, 'E' and 'F' can be discriminated by checking the presence of a horizontal line at the bottom. Two stimuli in a dimension set are consisted of the same parts but have different values that they take on a stimulus attribute dimension. For example, a leftward and a rightward parenthesis can be discriminated by their value on the orientation dimension. Garner (1978) reported that given different stimulus sets, participants showed different patterns of performance in a variety of classification tasks. For example, integral processing whereby each dimension of a stimulus cannot be selectively attended to was dominant in the dimension set, and separable processing whereby each dimension can be selectively attended to in the feature set. He proposed that different sets produce different types of attribute interaction, that is, either integral or separable processing. It is thus reasonable to expect that different modes of precedence should be observed with different stimulus sets. Park (1986) and Kim (1990) observed the global precedence in dimension sets and the local precedence in feature sets.

The principle of global precedence advocated by Navon (1977, 1991) and also by Paquet and Merikle (1988) predicts that global precedence must be observed under appropriate conditions. The opposing camp of researchers argues that precedence is dependent on attention allocation. Neither approach does predict that precedence can vary with the type of stimulus set. If it does, neither approach can hold its hypothesis without further revising some of its basic propositions. Discrimination between two global features or between two local features in a feature set needs detection of a distinctive feature (see Figure 1), and will be benefited by focal attention to such feature. Focal attention to a local region can facilitate local processing and result in the local precedence. However, discrimination between stimuli in a dimension set needs detection of a change of configuration, which can be easily processed by shallow but wide spatial attention over the whole pattern.

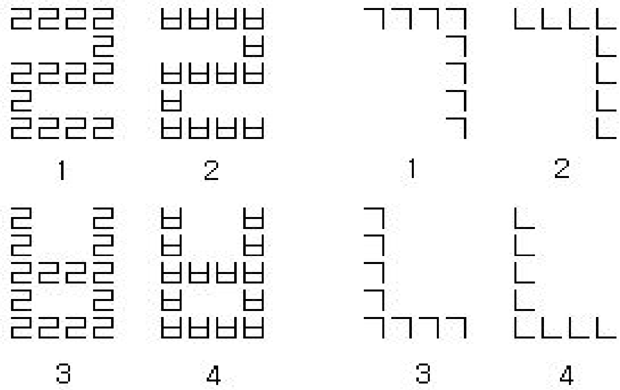

Figure 1. A feature compound stimulus set (4 left figures) and a dimension compound stimulus set (4 right figures). The global and the local level of stimuli 1 and 4 in each set are congruent and those levels of stimuli 2 and 3 incongruent.

This mode of attention may be useful to global processing, but can hinder local processing which requires focal attention on the local features. In short, local precedence should be observed in the feature set and global precedence in the dimension set.

In summary, the objective of this study was twofold: One was to investigate effects of attention shift to the global and the local level and between these levels in terms of global or local precedence; the other was to explore whether a given precedence would vary with the type of stimulus set.

Experiment 1

The goal of Experiment 1 was to compare speed of attention shift to the global level with that to the local level. Robertson et al., (1993) and Stoffer (1993) used visual cues preceding or overlapping in time with compound stimulus target. Because visual cues could have complicate interactions with compound stimuli, sound cues were used in Experiment 1. Participants had to attend to both the global and the local level of a compound stimulus till they heard a sound cue of a high or a low pitch. Given this cue, they had to shift their attention to one of the two levels so as to judge its identity. The sound cue was presented earlier or simultaneously with or later than the compound stimulus by 100 msec. As discussed before, the feature set and the dimension set of compound stimuli were constructed and contrasted (see Figure 1).

Ward (1982) asked participants to judge a global or a local level of two compound stimuli presented in sequence. They were told about which level of the first stimulus and which level of the second stimulus to be judged. He found that they could judge faster when the should-be-judged level of the second stimulus was the same as the level of the first stimulus which they have judged. This result might be caused by the fact that the order of level judgment was fixed through an experimental block. The level to be attended in the current experiment was randomly varied, so that there was a shift or no shift of attention levels trial by trial. The effect of level shift on performance would be examined in a later part of Experiment 1.

Method

Participants Twelve undergraduate and graduate students of psychology of department at the Seoul National University participated in this experiment. Their visual acuity was normal or corrected to normal.

Apparatus and stimuli The experiment was conducted in a little dimly illuminated room. An IBM-compatible PC and a monitor (amber colored) with 720 x 348 pixel resolution were used for stimulus presentation, measurement of reaction time, and procedure control. Each compound pattern was based on a 4 x 5 matrix of small letters. A small letter and a compound pattern had a scale of 9 x 11 mm and 42 x 62 mm in size, respectively. A circle with a diameter of 2.5 cm was used as a fixation. Each line had a thickness of 1 pixel. The display screen was placed at 60～75 cm away from a participant. The visual angle was 4.01～3.21(W) x 5.92～4.73(H) in degree for a large pattern.

Procedure A circle was presented for 300 msec at the center of the screen, followed by a compound pattern. One of two sound cues was presented 100 msec earlier than, or simultaneously with, or 100 msec later than the presentation of a compound pattern. The sound cues had a duration of 100 msec and two levels of tone (1320 and 440 Hz). Participants were instructed to identify a small letter on a high tone and a large letter on a low tone. The compound pattern was presented till they pressed a response key. Participants were instructed to judge whether the identity of the cued level was either 'ㄹ' or 'ㅂ' in the feature set condition, or either 'ㄱ' or 'ㄴ' in the dimension set condition. Five practice blocks of 40 trials, and 3 main experimental blocks of 64 trials were run with each participant. Three levels of SOA between the sound cue and visual pattern were manipulated between blocks. Attention levels and target identities were counterbalanced. There was about 3 sec interval between trials. Reaction time (i.e., RT) was measured from the presentation of a compound pattern to the press of a response key. Each participant served for the same experiment three times for 3 or 4 days, and the first two experiments were treated as a practice.

Design Stimulus set, a between-subject variable, had two levels, the feature set and the dimension set, each with 6 participants. The SOA between the sound cue and a compound pattern was a within-subject variable with three levels. Judgment level (global vs. local) and congruity between the global and the local level (congruent vs. incongruent) were also within- subject variables.

Results and Discussion

A repeated measure analysis of variance on RT data revealed following effects (see Figures 2 and 3). The RT for the incongruent stimulus was longer than RT for the congruent stimulus (that is, a significant Stroop interference), $F(1, 10) = 156.78$, $p < .001$, $MSE = 4117.94$. The RT increased linearly as a function of SOA, $F(1, 10) = 66.80$, $p < .001$, $MSE = 2208.03$. An interaction effect of stimulus set and congruity was significant, $F(1, 10) = 13.41$, $p < .01$, $MSE = 4117.94$, because a larger Stroop interference was observed in the dimension set than in the feature set, $t(10) = 3.66$, $p < .05$, $se = 321.39$. An interaction effect of congruity and SOA was significant, $F(2, 20) = 4.93$, $p < .05$, $MSE = 677.35$, because the amount of Stroop interference increased linearly as a function of SOA, $F(1, 10) = 8.40$, $p < .05$, $MSE = 792.14$. A three way interaction among stimulus set, judgment level, and congruity approached a significance, $F(1, 10) = 3.73$, $p = .082$, $MSE = 1924.00$, but its nature was not clear.

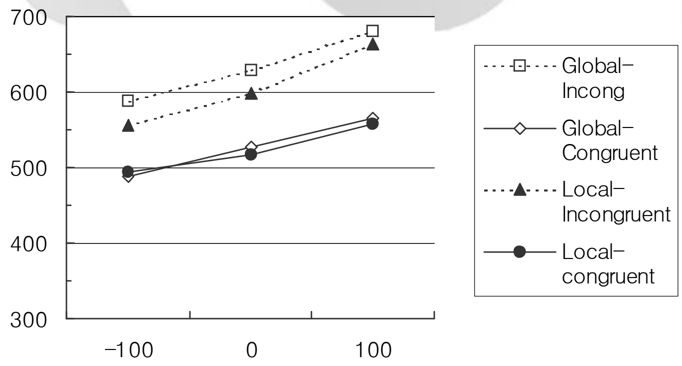

Figure 2. Mean RTs (msec) in each condition by levels and by congruity as a function of SOAs for the feature set in Experiment 1.

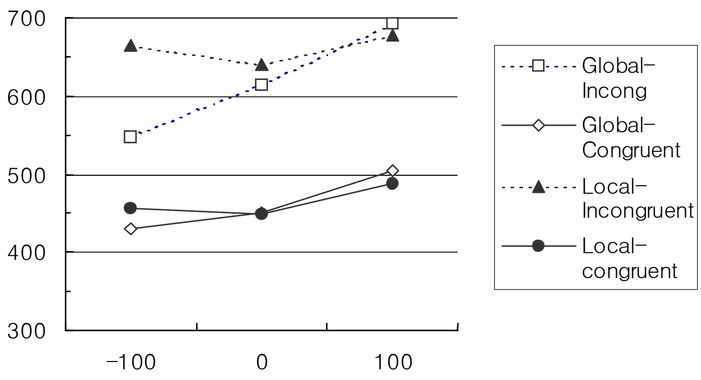

Figure 3. Mean RTs (msec) in each condition by levels and by congruity as a function of SOAs for the dimension set in Experiment 1.

Mean accuracy was 93.6% for the whole participants. A repeated measures analysis of variance on accuracy data showed that the congruent stimulus (98.0%) was more accurately judged than the incongruent stimulus (89.2%), $F(1, 10) = 62.37$, $p < .001$, $MSE = 100.27$. That is, Stroop interference was also observed in accuracy.

A large Stroop interference was observed both in the feature set and in the dimension set. Asymmetry of Stroop interference between the global and the local level, however, did not reach significance, though there was a tendency of asymmetry for both stimulus sets. The effect of SOA and its interaction with congruity indicates that as global and local information build up more and more, the interference between them also becomes larger.

Shift of attention can be studied by inter-trial analysis. Each trial could be classified into one of the four distinct states according to the two attention levels (global and local) and the two responses which participants selected (right and left). And there would be four types of state transition between a preceding trial and its succeeding one: 1) no shift, where both level and response of a succeeding trial were the same as those of its preceding one, 2) shift of level, where attention levels were shifted between trials, but with the same response, 3) shift of response, where selected responses were shifted between trials, but with the same level cued, 4) shift of both, where both the level and the response were shifted between trials. Type of state transition had a differential influence on RT histograms according to the type of stimulus set (Figure 4). Four levels of prior states were pooled, because this variable was not statistically significant. Three SOA conditions were also pooled, because this variable did not interact

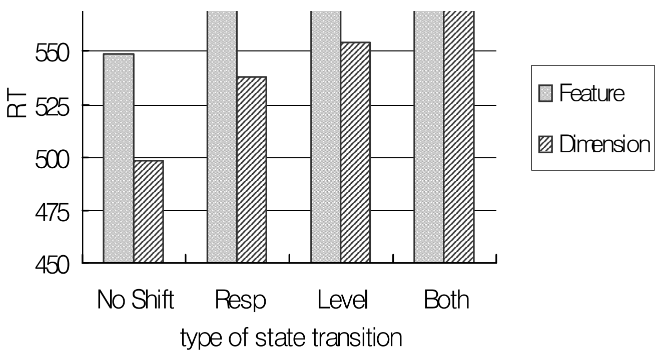

Figure 4. Mean RTs (msec) in each condition by types of state transition for the feature and for the dimension set of Experiment 1.

with other variables and had only a significant main effect. A repeated measures analysis of variance revealed the effect of the response shift, $F(1, 10) = 16.65$, $p < .01$, $MSE = 2824.67$, and an interaction between stimulus set and response shift, $F(1, 10) = 4.91$, $p = .051$, $MSE = 2824.67$, and an interaction between the level shift and the response shift, $F(1, 10) = 7.01$, $p < .05$, $MSE = 7392.92$. The level shift tended to be significant, $F(1, 10) = 4.62$, $p = .057$, $MSE = 24708.06$. For a further analysis, data of dimension and feature set were separately analyzed. In the dimension set, only the response shift was significant, $F(1, 5) = 35.97$, $p < .01$, $MSE = 129.82$. The level shift was not significant. In the feature set there was an interaction between the level shift and the response shift, $F(1, 5) = 13.18$, $p < .05$, $MSE = 296.38$. The level shift was significant when there was no response shift by a two-tailed t-test, $t(5) = 2.56$, $p = .05$, $se = 13.17$, but not significant when there was also a response shift. Results on accuracy were almost the same as those on RT, except for the absence of SOA effect.

Though it took much time to shift levels in the dimension set, there was no effect of the level shift because of a large error variance. This result indicates that shifting from an attended level is hard in the dimension set. Configural saliency might be resistant to such attention shift. For the feature set, shifting levels resulted in longer RTs. The both shift (level and response) did not increase RT compared to the no shift transition. How is it possible? The two levels may be related antagonistically and so may be the two responses. Concurrent antagonistic relation of both pairs could result in a fast reaction in shifting in the opposite direction to both. Shifting levels in the feature set took some time and seems to be more stable than that in the dimension set. The effect of inter-trial level transition on performance depended upon stimulus sets. This finding can be interpreted as suggesting that compound stimulus sets determine modes of attention shift between processing levels. It is thus difficult to explain this result by the notion of level readiness as proposed by Ward (1982).

Experiment 2

Attention shift to the global or local level in a compound stimulus was examined in Experiment 1 when participants were not asked beforehand to attend selectively to any level. The next question is concerning attention shift between those levels. After you saw the global level of a compound stimulus, you could shift your attention to the local level, or vice versa. Then, which direction of attention shift, from global to local or from local to global, is more quickly carried out?

Ward (1982) was interested in shift of levels between two compound stimuli presented in sequence. A shift between inter-stimulus levels would be different from a shift between intra-stimulus levels. A shift between the levels in the same stimulus should show an effect of stimulus structure as well. Prior designation of the order of to-be-judged levels does not guarantee the order of to-be-attended levels. To control for the attention order between the levels, compound stimuli were presented in two stages, either only the global or the local level at the first stage, and a complete stimulus in the next (see Figure 5). Participants should decide the identity of the level presented either at first or later. Since they did not know which level would be at first or later presented, they should attend to both levels presented in sequence. The task of judging the second level should thus require attention shift from the first level.

Method

Participants Twenty-four undergraduate students participated in Experiment 2, who enrolled in Introduction to Psychology at Seoul National University. Their visual acuity was normal or corrected to normal.

Apparatus and stimuli The apparatus was the same as that used in Experiment 1. The feature and the dimension set were also used. If either global or local level information was first presented, then the other hidden level was presented later, as shown in Figures 5 and 6. For example, after either a1 stimulus (global first) or a3 stimulus (local first) set was initially presented, it changed later into either b1 or b2 compound stimulus (global first - local later), or b1 or b3 compound stimulus (local first - global later), respectively. This transformation was

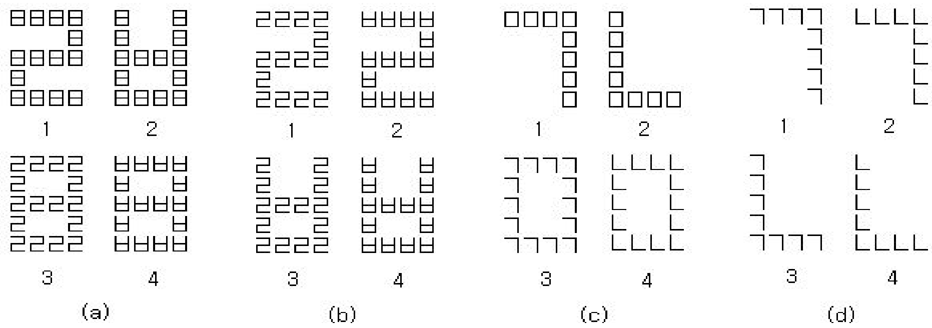

Figure 5. Stimulus displays used in Experiment 2. Eight left figures belong to a feature set and 8 right figures to a dimension set. Preceding figures are (a) and (c) in which upper figures represent the global level and lower ones the local level. Succeeding figures are (b) and (d) in which extra lines or elements in the preceding figures are removed.

applied to the dimension set, (c) and (d) in Figure 5, likewise.

Procedure A circle was presented for 300 msec at the center of the screen, followed by a compound pattern (see Figure 6). At first only one of the two levels could be identified by participants, because the other level was hidden by extra lines or elements (‘日’ in the feature set, and ‘ㅁ’ in the dimension set), and the hidden local or global information was later revealed. Participants could thus see the global

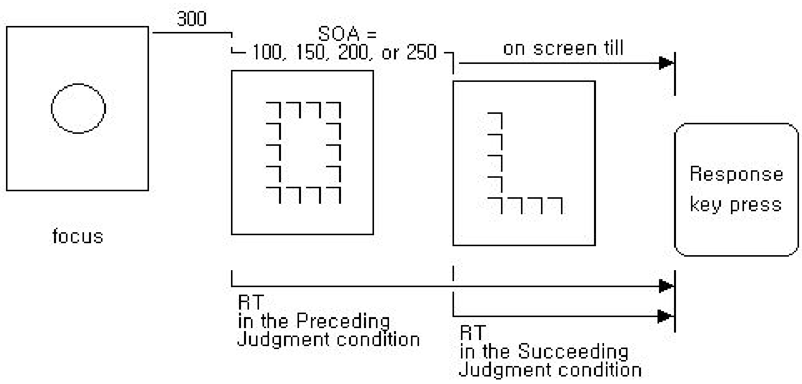

Figure 6. A preceding stimulus has either a global or a local information, the target of the Preceding Judgment condition (e.g, local ‘ㄱ’ in the figure). Its succeeding stimulus has both global and local information, and the target of the Succeeding Judgment condition is a newly disclosed one (e.g, global ‘ㄴ’ in the figure).

level first and the local level later, or in the opposite sequence. The SOA between presentations of the two levels varied by 50 msec from 100 msec to 250 msec. Participants were instructed to discriminate the identity of the level presented first in a *Preceding Judgment* condition, and to discriminate the identity of the level presented later in a *Succeeding Judgment* condition. Stimulus was presented till participants responded. One practice blocks and 4 main blocks of 5 exercise and 96 experimental trials were run with each participant. Two Preceeding and two Succeeding Judgment conditions were counterbalanced across experimental blocks. RT was measured from the presentation of the level to be judged.

Design Stimulus set (feature vs. dimension) was a between-subject variable. Sequence of judgment level (preceding vs. succeeding), SOA (100, 150, 200, 250 msec) between preceding and succeeding levels, judgment level (global vs. local) and congruity between global and local level (congruous vs. incongruous) were all within-subject variables.

Results and Discussion

Figures 7 and 8 show mean RT data for the feature and the dimension set, respectively. Mean RT was longer in the feature set (482 msec) than in the dimension set (435 msec), $F(1,22) = 6.43$, $p < .05$, $MSE = 64516.70$. Data of the two stimulus sets were separately analyzed considering the uniqueness of each stimulus set.

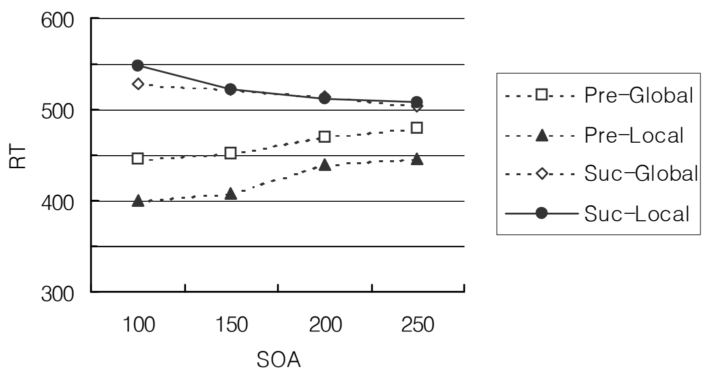

Figure 7. Mean RTs (msec) in each condition by sequence of judgment levels and by judgment levels as a function of SOAs for the feature set in Experiment 2 (In the legend, 'Pre' means 'preceding', and 'Suc' means 'succeeding').

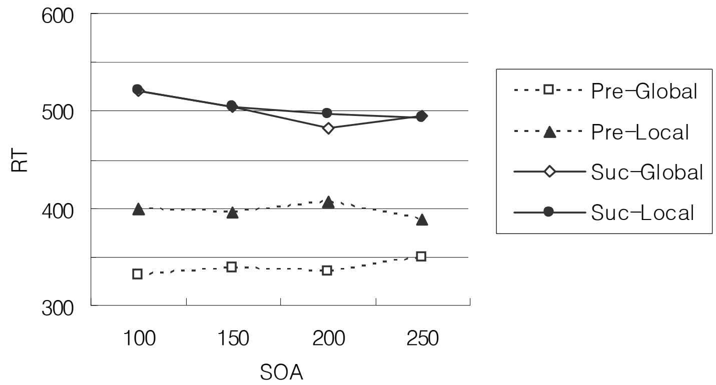

Figure 8. Mean RTs (msec) in each condition by sequence of judgment levels and by judgment levels as a function of SOAs for the dimension set in Experiment 2 (In the legend, 'Pre' means 'preceding', and 'Suc' means 'succeeding').

A repeated measures analysis of variance on RT data for the feature set revealed following effects. Judgment of the local level tended to be faster than that of the global level, $F(1,11) = 4.49$, $p < .1$, $MSE = 5737.18$. RT for preceding stimulus was shorter than that for succeeding stimulus, $F(1,11) = 33.41$, $p < .001$, $MSE = 17100.90$. An interaction effect between sequence and level was significant, $F(1,11) = 20.71$, $p < .01$, $MSE = 2218.44$. The difference between the global and the local level was significant in the preceding judgment condition, $t(11) = 4.13$, $p < .01$, $se = 9.27$, but the same difference in the succeeding judgment condition was not significant. An interaction effect between sequence and SOA was also significant, $F(3,33) = 24.56$, $p < .001$, $MSE = 1015.19$. As the SOA increased, RT for preceding stimulus became linearly longer, $F(1,11) = 29.08$, $p < .001$, 7 $MSE = 415.19$, while RT for succeeding stimulus became linearly shorter, $F(1,11) = 24.20$, $p < .001$, $MSE = 77.33$.

A repeated measures analysis of variance revealed following effects for the dimension set. The global level was judged faster than the local level, $F(1,11) = 31.77$, $p < .001$, $MSE = 2892.44$. RT for preceding stimulus was shorter than that of succeeding stimulus, $F(1,11) = 85.01$, $p < .001$, $MSE = 20368.64$. An interaction effect between sequence and level was significant, $F(1,11) = 14.14$, $p < .01$, $MSE = 5309.07$. The difference between the global and the local level was significant in the preceding judgment condition, $t(11) = 9.91$, $p < .001$, $se = 5.95$, but not in the succeeding judgment condition. A main effect of SOA was observed, $F(3,33) = 3.41$, $p < .05$, $MSE = 912.57$. An interaction effect between sequence and SOA was also significant, $F(3,33) = 4.50$, $p < .01$, $MSE = 1225.84$. As the SOA increased, RT for succeeding stimulus showed a linear decrease trend, $F(1,11) = 14.40$, $p < .01$, $MSE = 329.61$, and a quadratic trend, $F(1,11) = 5.43$, $p < .05$, $MSE = 244.04$. No such trend with SOA was significant in the preceding judgment condition. Unlike the feature set, congruity significantly interacted with level, $F(1,11) = 11.93$, $p < .01$, $MSE = 1884.11$, and with sequence and level, $F(1,11) = 13.25$, $p < .01$, $MSE = 2731.65$. This was because a large Stroop interference was obtained in the global level (46 msec) whereas a large negative Stroop interference (-24 msec; Stroop facilitation) was observed in the local level (See Table 1). This result was quite apparent in the succeeding judgment condition.

An overall mean of accuracy was 95.5% for the feature set, and 97.6% for the dimension set. A repeated measures analysis of variance on accuracy showed no effect in the feature set. The accuracy analysis of the dimension set produced a similar pattern with its corresponding RT analysis, except for the congruity effect, $F(1,11) = 7.46$, $p < .05$, $MSE = 114.94$, and an interaction of congruity and sequence, $F(1,11) = 11.54$, $p < .01$, $MSE = 57.78$. These effects were found because marginal accuracy (99.0%) of a preceding global feature was better by 3.4% than the other three conditions. There was no speed-accuracy tradeoff.

The results of Experiment 2 indicate that at an initial presentation of the compound stimulus, attention can shift faster to the local than to the global level in the feature set and that it can shift more quickly to the global than to the local level in the dimension set. This result replicates the same tendency observed in Experiment 1, and suggests attention shift to the local precedes in the feature set and attention shift to the global precedes in the dimension set. Though there were mean RT differences in both stimulus sets in the preceding judgment condition, no such difference was obtained in the succeeding judgment condition. This suggests no difference in discriminability between the global and the local in both sets, that is, the two levels were equally discriminable in both sets. When SOA increased, RT for preceding stimulus in the feature set increased accordingly, while RT for preceding stimulus in the dimension set maintained a very low value with no change. This result is interesting, because it indicates that mode of attention shift depends on the type of stimulus set. Attention shift in the feature set progresses relatively slow and steady whereas attention shift in the dimension set seems to be made suddenly. Asymmetry of Stroop interferences between the global level and the local level in the succeeding stimulus of the dimension set could not be interpreted straightforward, rather it seems to show heuristic processing in this set (Table 1). When the global level was first

Table 1. Mean RT (msec) for Each Condition by Stimulus Set, Presentation Order, Judgment Level and by Congruity. Four SOA Levels Were Pooled. Numbers at the Bottom Indicate the Amount of Stroop Interference.

	feature				*dimension*			
	preceding		*succeeding*		*preceding*		*succeeding*	
congruity	*global*	*local*	*global*	*local*	*global*	*local*	*global*	*local*
incongruent	467	427	515	519	338	401	524	492
congruent	457	421	520	527	340	395	478	516
Stroop interference	10	6	-5	-8	-2	6	46	-24

Note. If participants saw first a global level of preceding stimulus, they came to see later a local level of succeeding stimulus and vice versa. The difference between each pair is mean time for level shift with SOAs pooled.

presented and the local level was later disclosed as in a pair of c1 - d1 or c1 - d2 in Figure 5, participants might be able to detect the contour change more quickly in d2 (incongruent) than in d1 (congruent). This is because contour description of d1 is the same as c1. However, when presentation sequence was from local to global as in a pair of c3 - d1 or c3 - d3, participants might be able to identify d1 (congruent) more aptly than d3 (incongruent), because continuity of contour is better in d1 than in d3.

To decide the identity of a following stimulus, participants should also attend to its preceding stimulus, because they could not tell what preceded from what follows after extra lines or elements are removed. Therefore time for attention shift from a preceding to a succeeding level was included in total response time for the succeeding stimulus. Time taken for attention shift between the levels can be obtained by subtracting RT for the preceding stimulus from RT for the succeeding stimulus. Various effects probably would be involved in the time taken for attention shift, but if it were by and large constant we can compare attention shift time in the feature set with that in the dimension set. Figure 9 shows time for attention shift from global to local or from local to global. Shift time was shorter in the feature set (77 msec) than in the dimension set (134 msec), $F(1,22) = 8.37$, $p < .01$, $MSE = 37469.54$. A repeated measures analysis of variance on shift time indicated that for the feature set attention shift from a global to a local level tended to be easier than the shift in the opposite direction, $F(1,11) = 4.50$, $p = .058$, $MSE = 11474.35$, and shift time of both directions decreased linearly as a function of SOA, $F(1,11) = 83.03$, $p < .001$, $MSE = 1772.45$. Attention shift from local to global level was easier in the dimension set than

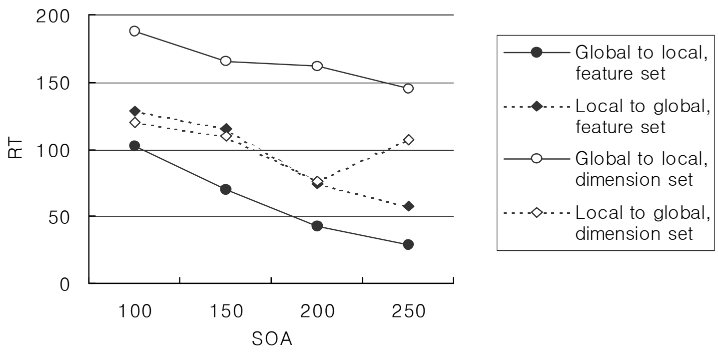

Figure 9. Mean RT (msec) for shift time from global to local and also from local to global as a function of SOA for each stimulus set.

shift in the opposite direction, $F(1,11) = 31.64$, $p < .0001$, $MSE = 5784.88$. As SOA increased, attention shift from global to local had a trend of linear decrease, $F(1,11) = 19.84$, $p < .001$, $MSE = 531.34$, while attention shift from local to global had a quadratic trend, $F(1,11) = 5.76$, $p < .05$, $MSE = 837.98$. There was also an interaction of shift direction and congruity, $F(1,11) = 12.01$, $p < .01$, $MSE = 3768.21$. As shown in Table 1 and discussed in the previous paragraph, global-to-local shift took more time in the congruent stimulus (176 msec) than incongruent stimulus (154 msec), but local-to- global shift took more time in the incongruent stimulus (123 msec) than in the congruent stimulus (83 msec).

Results on shift time are consistence with those of the previous analysis. Though mean RT was longer in the feature set than in the dimension set, shift time was shorter in the former set than in the latter set. This indicates attention is more tightly anchored to either the global or the local level in the dimension set, possibly because stimuli in the dimension set have distinct configurations which can easily attract attention. As the SOA increased, attention shift to the other level became easier (except for a quadratic tendency in shift from local to global in the dimension set). That is, processing of a succeeding stimulus could become free of the influence of a preceding stimulus, as their processing overlapped less and less in time course.

General Discussion

Two experiments examined modes of attention shift to the global versus the local level in the two types of compound stimulus set. In

Experiment 1, the feature and the dimension set showed similar patterns of results, except that more Stroop interference was observed in the dimension set than in the feature set. But the analysis of inter-trial state transition showed modes of attention shift dependent upon the type of stimulus set. Shift of level in the feature set produced longer RT than did no shift when there was no shift of response, while there was no effect of level shift in the dimension set. In Experiment 2, participants in the succeeding judgment condition were required to shift attention from either level of the preceding stimulus. Attention shift to the local was easier than shift to the global in the feature set, and this relation was reversed in the dimension set. A trend analysis of RT as a function of SOA also showed that stimuli of the dimension set could be attended to faster and longer than those of the feature set.

The results of the present study show what has been called global precedence is neither a perceptual principle nor a general phenomenon. In view of dynamics of attention, the local level has superiority over the global level in the feature set, and the global level over the local level in the dimension set. This indicates that the type of stimulus set should be counted as an important factor in precedence research. Stimulus structure as defined and made distinct in terms of stimulus set can have an effect on how a compound stimulus attracts attention and how its global and local level will be processed. Navon and Norman (1983) argued global precedence would be still observed if eccentricity of the global and local level were equal, using compound stimuli with local letters only in the margin (see Park, 2003, against their argument). When precedence is interpreted in this way, precedence will give us little implication about form perception. How many things can you imagine without their interiors? Though the eccentricity requirement suggested by Navon and Norman (1983) was not realized in the feature set of the present study, type of stimulus set was found to be another significant constraint of precedence.

Could it be possible to interpret the effect of stimulus set type in another way? Since the feature set stimuli look more complex than the dimension set stimuli, you might infer that precedence or superiority is affected by stimulus complexity.[1] Although global precedence was observed with feature set consisting of ‘ㄱ’ and 'ㅋ' stimuli (Kim, 1990), many feature sets have produced local precedence (Kim, 1990; Park, 1986). In addition, a dimension set having relatively complex pattern like compound arrows produced global precedence (Park, 1986). Unfortunately, there was no such study that manipulated stimulus set type and stimulus

1) This hypothesis, once treated by Kim (1990), was suggested by a reviewer.

complexity independently. Nevertheless, we would like to argue for the hypothesis of stimulus set type, because the stimulus complexity hypothesis speaks little on how either global or local precedence is observed.

Ward (1982) found that participants could judge quickly the same level as the level they judged just before. His level-readiness effect, however, was not observed in the present study. In Experiment 1, RTs for shift of both levels and responses were as fast as RTs for no shift (that is, level repetition). The level-readiness effect is likely to arise from anticipation of a specific level, but not from repetition of judgment on the same level, as Ward (1982) interpreted. In other words, the level-readiness effect might be based on a cognitive factor, not on a perceptual one. Though Robertson et al. (1993) and Stoffer (1993) observed global and local cue validity effects, they could not observe any Stroop interferences between the two levels at the same time. Experiment 1 obtained Stroop interferences in exchange of cue validity effects.

Shift of spatial attention can be conceptualized as having three stages such as disengagement, movement, and engagement (Posner, 1988). Does attention shift on compound stimulus require spatial movement? Or what does attention shift between levels refer to exactly? Both the global and the local feature exist at the same area, but they may have different scales. Attention shift between levels may be a matter of resolution, or a matter of spatial focusing and expansion, or both, like a zoom-lens (c.f., Stoffer, 1993 for attentional zooming). If attention to the global and the local level has a characteristic of spatial attention, it would be plausible to consider that attention shift between levels of a compound stimulus involves the same three stages as Posner proposed. Results of Experiment 2 could be easily understood by Posner's (1988) scheme. Attention shift can be conceptualized in another way. For example, attention shift can be thought as a kind of switching between processing channels with many leakage (crosstalk) points (c.f., Pomerantz, Pristach, & Carson, 1989). According to this metaphor, easiness of a shift would be determined by the amount of allocated resource, relative speed of processing channels, and the extent of crosstalk, etc. It is plausible a couple of attention mechanisms are involved in the processing of compound stimulus. To distinguish these possibilities, further study is needed.

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형태의 전역 및 국지 수준으로의 주의 전환에 대한 자극별의 영향

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특징 혹은 차원 자극벌(Garner, 1978)이 복합 자극의 전역 혹은 국지 수준으로의 주의 전환 양상에 미치는 영향을 조사하기 위해 두 실험이 수행되었다. 실험 1에서, 시행간에 걸쳐 주의 받은 수준의 전환에 대한 분석은 특징 자극벌에서는 수준 전환 효과를 보였으나, 차원 자극벌에서는 그런 효과를 발견하지 못하였다. 실험 2에서, 복합 자극의 두 수준의 정체를 순차적으로 제시함으로써 수준간 주의 전환이 강제되었다. 특징 자극벌에서 국지 수준으로의 주의 전환이 전역 수준으로의 주의 전환보다 더 쉬웠다. 그러나, 차원 자극벌에서는 전역 수준으로의 전환이 국지 수준으로의 전환보다 더 쉬웠으며, 각 수준에 대한 주의가 신속하고 안정적인 것으로 보였다. 이 결과는, 전역 수준의 주의 및 지각이 선행함을 주장하는 전역 선행성(Navon, 1977)이 일반적 규칙이 아니며 자극 구조가 선행성 연구에서 중요한 요인으로 고려되어야 함을 시사한다. 수준 준비성 효과(Ward, 1982) 및 공간 주의 전환의 단계들(Posner, 1988)이 종합논의에서 고찰되었다.

주제어: 자극벌, 특징, 차원, 주의 전환, 복합 자극, 선행성