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物體表徵與物體為基注意力的機制
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行政院國家科學委員會補助專題研究計畫成果報告

物體表徵與物體為基注意力的機制

計畫類別：■ 個別型計畫　　□ 整合型計畫
計畫編號：NSC－2413-H－002－020
執行期間：2006 年 8 月 1 日　至　2007 年 7 月 31 日

計畫主持人：葉素玲
共同主持人：
計畫參與人員： 何明洲

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執行單位：台灣大學心理學系暨研究所

中　華　民　國　96　年　10　月　31　日

摘要

本計畫主要以兩個系列的實驗來回答物體為基注意力的兩個問題：(1)物體表徵和物體效應的關係，以及(2)由上而下和由下而上的處理歷程對物體為基注意力的影響。實驗採用 Egly，Driver，與 Rafal (1994)的雙方框提示派典的變形。每一嘗試開始時，有一個線索出現在雙方框的其中一端，而當目標出現在與提示端為相同物體時，觀察者的反應若快於當目標出現在不同物體處，表示具有物體效應，此即物體為基注意力的指標。系列一的四個實驗系統性地操弄目標畫面上的物體消失的比例 (0%, 20%, 80%)，結果發現無論比例的高低，只要原先的物體在目標畫面消失不出現，便沒有物體效應，顯示即時的物體表徵是必須的。系列二的四個實驗則在目標畫面出現的瞬間，將原先的雙方框改變成一個迴力鏢，其改變的比例與系列一相同。結果顯示只要在整個實驗中迴力鏢曾經出現過，即使比例僅有 20%，其出現的方向就會影響雙方框持續出現直到目標畫面的物體效應，顯示經驗與預期的重要性。總結兩系列的八個實驗可知，連續的物體表徵和對改變的經驗與預期都是影響物體為基注意力的重要因素。

關鍵詞：物體為基注意力，表徵，位置，機率

Abstract

This project examines two related issues regarding object-based attention: (1) the relationship between the updating object representations and the object effects, and (2) effects of top-down and bottom up constraints on object-based attention. Modifications of the double-rectangle cuing paradigm of Egly, Driver, and Rafal (1994) were used. Each trial started with a cue that flashed in one of four ends of the two parallel rectangles to indicate the possible location of the forthcoming target, and faster response to the target on the cued rectangle than on the uncued one (i.e., the same-object effect) is taken as an index of object-based attention. The four experiments in series I demonstrated that the same-object effect was absent as long as the rectangles disappeared in the target frame, regardless of its probability (0%, 20%, 80%), indicating the importance of instantaneous object inputs for object-based attention. The four experiments in series II had similar probability manipulation, but the empty space in the target frame was now replaced by a boomerang. Results showed that the ever occurrence of the boomerang, even with a probability of appearance as low as 20%, influences the same-object effect of the rectangles that were shown in the target frame. We conclude that both continuous object representation and expectation on and experience with another object are important for object-based attention.

Keywords: Object-based attention, representation, location, probability

計畫成果自評：

本計畫已經完成兩系列八個實驗。

相關成果也已分別在國際會議發表

Ho, M. C., & Yeh, S. L.* (2006). Object-based attention relies on instantaneous object representation, but not on the likelihood of object presence. *Vision*, v. 18 (supplement for ACV 2006), p.58. Oral presentation at the 4th Asian Conference on Vision. Matsue, Japan.

Ho, M. C., & Yeh, S. L.* (2007). Effects of bottom-up input and top-down expectation on object-based attention. *Journal of Vision, 7*, 306a. Poster presented at Vision Science Society, 7th Annual Meeting. Sarasota, Florida.

詳細內容參見以下即將投稿的論文（co-author: Ming-Chou Ho）

Due to the limited capacity of our cognitive system, selection is necessary to prevent overloading. The units of selection can be discrete objects (e.g., Duncan, 1984; Vecera, 1994), in addition to spatial locations (e.g., Posner,1980; Eriksen & Yeh,1986). Egly, Driver, and Rafal (1994) used a cueing paradigm with a now popular double-rectangle display to demonstrate this object-based attention. Two outline rectangles were shown and one end of a rectangle was brightened as a cue to indicate the possible location of a target. The target was a small solid square, shown subsequently within one end of a rectangle. The *same-object effect* was obtained and used as the index for object-based attention: Shorter RTs for an invalidly cued target that appeared at the other end of the cued rectangle than at the uncued rectangle, when the cue-target distances were equalized in these two conditions to control for space-based selection.

Many researchers have adopted this paradigm to investigate various properties of object-based attention (for a review, see Scholl, 2001). In studies that use this paradigm, the objects usually persist in the display throughout the trial (e.g., Egly et al., 1994), or are partly occluded as are many real-world objects (e.g., Moore, Yantis, & Vaughan, 1998, Pratt & Sekular, 2001; Tipper & Weaver, 1998). Given the persistence of object displays in past studies, it remains unknown whether and to what extent object-based attention is affected when the attended object disappears or changes after it has been cued, although some inferences can be drawn. For example, on the one hand, when attention is cued to the target object and selects it for further processing, it should be *this* cued object that remains being selected as a processing unit. Thus it is reasonable to hypothesize that the originally cued object, rather than the changed one after the cue, determines the object-based attention. On the other hand, however, the retinal inputs of our visual world change constantly, and so do our experiences and behavioral goals. Our visual system should thus reflect complexities as such; namely, it should be the *changed* one, rather than the originally cued object, determines the object-based attention.

A third possibility is that attention selects the cued location as an anchor, and from there it spreads through the object boundary when the cued object persists (Egly et al., 1994). When the cued object disappears from view, only the cued location remains operating (Brown & Denny, 2007) and perhaps used to connect with the replacing object. A hint of this comes from Lamy and Tsal (2000). In their Experiment 1, they presented two objects (one rectangle and one hourglass) with different colors and then, before the target was shown, swapped the cued and the uncued object to decouple the location and the feature of objects. They found that after switching, detecting a target on the previously cued object location (but now occupied by a different object) was faster than on the previously uncued object location (but now occupied by the cued object). Lamy and Tsal suggested that when the continuity of object file was disrupted by a sudden swap, attention selects object locations, not object features.

In the study of Lamy and Tsal (2000), the objects had been previewed before a sudden switch took place and the two objects were simply switched, with each identity remaining the same except for their locations. Our study employed a more dramatic object change and examines how such change would affect object-based attention. More specifically, we examined that, whether the top-down effect would be strong enough to hold the original object effect when the object inputs are cut off instantaneously in the last minute when the target is shown. In other words, if the attended object disappears from the target display, whether the experience of seeing that object in the beginning of a trial will direct attention to the empty space that is previously occupied by the attended object. Further, if the attended object is replaced with another object in the target display, how does the experience of having attended to the original object and seeing a different object afterwards interplay to determine the cueing effect?

Many have shown that one's expectation on some events (e.g., expecting a target to appear in a specific location, e.g., Shomstein & Yantis, 2002, 2004; e.g., expecting the continuous existence of the occluded object, e.g., Jefferies, Wright, & Di Lollo, 2005) can influence attentional control in a scene. Also, even for attentional capture by task-irrelevant distractors, top-down attention control settings are crucial in most circumstances to determine the attention allocation (Folk, et al., 1992, 1994; Liao & Yeh, 2007). Thus, top-down effects seem strong and, although it is undeniable that bottom-up stimulus inputs are important as well, the former may weight heavier than the latter. To further differentiate the top-down effects, we also manipulated the probability of object presence to examine whether the expectation on object presence could influence object-based attention.

The above questions are associated with a more general issue: Does the effects of the top-down constraints (i.e., the expectation/experience of seeing the objects) depend on the continuity of the bottom-up object inputs? That is, whether the top-down constraints are more effective when the continuity of the bottom-up object inputs is maintained rather than disrupted (e.g., disappearance or replacement). This issue is important considering the dynamic, ever changing, visual world our visual system faces at every moment. Given the constantly changed visual world, how the top-down expectation/experience and the bottom-up object inputs interplay to decide the object-based attention is an important issue; however, previous studies emphasize one or the other, but not both. The current study aims at examining both top-down and bottom-up factors in object-based attention within the same experimental framework.

We used the objects (the double rectangles) similar to those of Egly et al. (1994)

and manipulated their presence in the target frame. In the target frame, participants needed to detect the onset of the target square. Throughout the trials, the rectangles either persisted until after response as in the conventional Egly's display, or they were altered in two different ways: (1) they disappeared from view in the target display (Experiments 1 to 3), or (2) they were replaced with a new object (Experiments 4 and 5). In the first series of experiments (Experiments 1 to 3), the probability of presence (vs. disappearance) of the rectangles in the target frame throughout the experiment was manipulated to examine how the participants' expectations on object presence influence their performance. When the rectangles suddenly disappear from the target frame, if the experience of seeing the rectangles in previous frames in a trial is sufficient to direct attention, attention should have already been directed to the empty space previously occupied by the cued rectangle, causing a typical same-object effect. In such a case, the bottom-up object input is presumably not critical for attentional control, because the experience of seeing the rectangles *per se* is sufficient to guide attention. In this case, then, the probability of presence of the rectangles in the target frame should affect the object-based attention; the higher the probability, the better the chance to maintain the object-based attention even if the rectangles disappear from view n in the target frame. In contrast, if the same-object effect is found only when the rectangles are present in the target frame, but not when they are absent, then continuous object inputs should be considered critical to guide attention, and the probability of presence of the rectangles in the target frame should *not* affect the object-based attention

In the second series of experiments (Experiments 4 and 5), similar to the first series, we manipulated the probability of presence of the rectangles (vs. replacement of them in the target frame with a boomerang) to examine how the expectation of the old object presence influences participants' performance. That is, the rectangles could either persist through the trial or be replaced with a different object in the target frame with different probabilities. Many have suggested that experiencing seeing the other object is one of the top-down constraints that contribute to object-based attention (Chen, 1998; Zemel, Behrmann, Mozer, & Bavelier, 2002) but this is without controversy (Pratt & Sekuler, 2001). For example, Zemel et al. (2002) demonstrated that the short-term exposure of the other object could influence the later interpretation of the occluded objects and further influence the same-object effects. However, Pratt and Sekuler (2001) showed that experience of seeing other objects could not halt the later amodal completion of objects. We suspect that the expectation of seeing the other object might affect the results differently, thus on top of the within-trial experience of seeing the other object, we added further manipulation of probability (e.g., the expectation across trials) to strengthen the top-down constraints and to disentangle the top-down effects of the two kinds, just like that in the first series of experiments.

The prediction is as follows. If the experience of seeing the original objects (e.g., two rectangles) in a trial could influence attentional control in the ongoing scene, the same-object effect obtained from this scene should be determined by the object with previous experience. On top of that, the probability of presence of the other object (e.g., a boomerang) in the target frame should also affect the object-based attention; the higher the probability, the better the chance to maintain the object-based attention even if the rectangles are replaced by the boomerang in the target frame. In contrast, if the experience of seeing the original objects is not important to guide attention, the same-object effect should be determined by the objects in the current scene only, and the probability manipulation should not exert any effect.

Four terms are defined here. The *within-trial experience* indicates the experience of seeing the rectangles in the frames prior to the target frame within a trial. The *across-trial experience* refers to the experience of seeing the boomerang in previous trials. The *expectation on object presence* indicates the manipulated probability of object presence in the target frame (in first series of experiments, the object refers to the rectangles; in second series of experiments, the object refers to the boomerang). The *expectation on boomerang orientation* indicates the manipulated orientation of the boomerang, changed with the cued location to influence the same-object effect when the two rectangles were presented in the target frame, which is manipulated in the second series of experiments.

Overview of this study

In all the experiments, the two parallel rectangles persisted in the display before the onset of the target. The first series of experiments contained two rectangles in the cue frame and the probability of their presence in the target frame was manipulated as follows. In Experiment 1, the rectangles were always present in the target frame (100% object presence) and in Experiment 2 they were always absent (0% object presence). In Experiments 3A and 3B, the rectangles appeared in the target frame in 20% and 80% of total trials respectively. In the trials when the rectangles were absent in the target frame, the previously presented rectangles disappeared and left with only the target square in the target-present trials (and with an empty space in the target-absent, catch, trials).

In the second series of experiments, a different object (a boomerang) appeared in the target frame in different proportions (80% or 20%) of all trials. For the trials in which the boomerang appeared, the rectangles were replaced by a boomerang in the target frame. In contrast, for the trials where the boomerang did not appear, the rectangles persisted in the display through the trial. In the trials where the boomerang appeared, we manipulated the *expectation on boomerang orientation* in terms of the cued location. Such manipulation is to examine the effect of across-trial experience of having seen the boomerang on the same-object effect when the rectangles persisted in the target frame. In Experiments 4A and 4B, the orientation of the boomerang changed with the cued location in the direction to *reduce* the same-object effect when the two rectangles were presented in the target frame. In Experiments 5A and 5B, the orientation of the boomerang changed with the cued location in the direction to *facilitate* the same-object effect when the two rectangles were presented.

Experiment 1: 100% object presence probability in the target frame

The purpose of the current experiment was to replicate the findings of Egly et al. (1994) by employing a similar design. This provides a baseline for the comparison with other probability manipulations.

Method

Participants

Eighteen undergraduates of the National Taiwan University served as participants in this experiment in exchange for course credit. All had had normal or corrected-to-normal vision.

Apparatus

The stimuli were constructed with, and controlled by, the E-prime software (Schneider, Eschman, & Zuccolotto, 2002), using an IBM compatible personal computer with a 17 inch calibrated View Sonic color monitor (at a refresh rate of 85Hz). The viewing distance was 80 cm.

Design and procedure

The design and procedure of this experiment were similar to those of Egly et al. (1994). At the beginning of each trial, a central fixation (a plus sign) and two vertical rectangles (2° x 16°) appeared for 1000 ms (see Figure 1). These two rectangles were at the left 7° and right 7° eccentricity. Because the spatial extent of initial focusing of attention modulates the same-object effect (Goldsmith & Yeari, 2003), we added a pre-cue event (four Ls, 3° x 3°, surrounding the two rectangles) to expand the focus of attention that includes the two rectangles. The distance between the corner of each L and the central fixation was 14.6°. The four Ls appeared for 35 ms.

Seventy ms after the offset of the four Ls, a red cue (consisting of the object outline at one end of the object) was presented with 76% location validity at one of the four ends of the two rectangles. The cue was presented for 100 ms and the target (a grey square, 2° x 2°) appeared 200 ms after the cue’s offset. On the invalid trials, the target could appear on the uncued location occupied by the cued object (50%; invalid-same condition) or at an equidistant location on an uncued object (50%; invalid-different condition). The target remained on until the participants’ response or 2 sec, and the latter was recorded as an error. In addition, catch trials with no target consisted of 20% of all trials. When participants responded in the catch trial, it was recorded as an error and a sound feedback was given.

The experiment contained 30 practice trials and 600 formal trials (380 valid, 120 invalid, and 100 catch trials). The variable of interest was cue validity (valid, invalid-same, invalid-different). All conditions (three validity and catch trials) were randomized within trials.

Results and discussion

Results are shown in Table 1. The false alarm rate was 3 % and the miss rate was 0.6 %. RTs (based on correct responses) faster than 150 ms and beyond three standard deviations from the mean RT in each condition were removed. The removal rate was 2.8 %. A one-way analysis of variance (ANOVA) of target locations (valid, invalid-same, and invalid-different locations) for RTs was significant [$F(2,34) = 32.27$, MSe = 302.2, $p < .0001$]. All paired comparisons made under the Shaffer procedure were significantly different. The significant difference between the invalid-same and invalid different locations (13 ms) indicated a same-object effect. This replicates the finding of Egly et al. (1994) and indicates that when objects are continuously present throughout the trial, attention is directed to the cued object for target detection. Having established this basic result, we made the object disappear from the target frame in the next experiment to examine whether object-based attention still hold under such a condition.

Experiment 2: 0% object presence probability in the target frame

This experiment aimed to examine the same-object effect when the cued and attended rectangles disappeared in the target frame in each trial.

Method

Participants

Another group of 18 undergraduates with the same characteristics as described in Experiment 1 participated in this experiment.

Apparatus, Design, and procedure

The apparatus, design, and procedure were similar to those of Experiment 1 in this experiment and the following, and we only specified the difference in each experiment. The originally presented objects were always absent in the target frame in Experiment 2. The experiment consists of 30 practice trials and 600 formal trials (380 valid, 120 invalid, and 100 catch trials).

Results and discussion

The false alarm rate was 4.5 % and the miss rate was 0.6 %. The same exclusion criteria were used and the removal rate was 2.5 %. A one-way ANOVA of target locations (valid, invalid-same, and invalid-different locations) for RTs was significant [$F(2,34) = 54.42$, MSe = 169.3, $p < .0001$]. All paired comparisons, except for that between invalid-same and invalid-different locations (mean RT difference = 5 ms, p

= .3, η_p^2 =.06), reaching the Shaffer-controlled significance level. The results showed that the typical same-object effects were not found when the objects disappeared in the target frame (see also Yeh, Lin, & Guo, 2005). This indicates that when no objects in the target frame, no object-based attention exists, even though the objects have been present and been cued throughout the trial except for the last frame.

In the current experiment, the objects were always absent in the target frame. In the following experiments, we manipulated the probability of object presence in the target frame to examine whether the occurrence of same-object effects was modulated by this probability.

Experiment 3A: 20% object presence probability

Method

Participants

Another group of 25 undergraduates with the same characteristics as described in Experiment 1 participated in this experiment.

Design and procedure

In the current experiment, objects appeared in the target frame for 20% of trials (120 trials; 76 valid, 24 invalid, and 20 catch trials) and were absent for the rest 80% of trials (480 trials; 304 valid, 96 invalid, and 80 catch trials). The same object presence probability was applied in the practice trials (6 object-present trials and 24 object-absent trials).

Results and discussion

The false alarm rate was 2.6 % and the miss rate was .05 %. The same exclusion criteria were used, resulting in a removal of 2.0 % of the trials. A two-way ANOVA of object presence (presence or absence) by target locations (valid, invalid-same, or invalid-different locations) for RTs showed significant main effects of object presence [$F(1,24) = 7.09$, MSe = 379.2, $p < .05$], target locations [$F(2,48) = 109.46$, MSe = 243.5, $p < .0001$], and an interaction [$F(2,48) = 9.26$, MSe = 135.4, $p < .0001$]. The main effect of object presence showed that RTs were faster when the objects were present (394 ms) than when they were absent (403 ms). The main effect of target locations showed that the mean RT in the valid condition (372 ms) was faster than that in the invalid-same condition (408 ms) and invalid-different condition (415 ms).

For the interaction effect, multiple paired comparisons were conducted respectively for each of two object presence conditions (presence and absence) under the control of the Shaffer procedure. When the objects were presented in the target frame, all paired comparisons were significant. The significant RT difference (10 ms) between the invalid-same and invalid-different conditions indicated an object effect ($p < .05$). On the other hand, when the objects were absent in the target frame, all pairs, but the difference between invalid-same and invalid-different conditions, were significant. The non-significant RT difference (3 ms) between the invalid-same and invalid-different conditions showed the absence of same-object effect (p = .284, η_p^2 =.05).

Thus, when the objects were absent in the target frame, the same-object effect was not found. However, when the objects were present in the target frame, the same-object effect was still observed, even though the object presence probability in the target frame was as low as 20%.

It is possible that when the object presence probability increases, attention can scan the empty space previously occupied by the cued object in higher priority, causing the same-object effect. The next experiment tested this possibility.

Experiment 3B: 80% object presence probability

Method

Participants

Another group of 25 undergraduates with the same characteristics as described in Experiment 1 participated in this experiment.

Design and procedure

In the current experiment, objects appeared in the target frame in 80% of trials (480 trials; 304 valid, 96 invalid, and 80 catch trials) and were absent in the rest 20% of trials (120 trials; 76 valid, 24 invalid, and 20 catch trials). Also the same presence probability was applied in the practice trials (24 object-present trials and 6 object-absent trials).

Results and discussion

The false alarm rate was 3.2 % and miss rate was .2 %. The same exclusion criteria resulted in removal of 1.7 % of the trials. A two-way ANOVA of object presence (presence or absence) by target locations (valid, invalid-same, or invalid-different locations) for RTs showed significant main effects of object presence [F(1,24) = 185.39, MSe = 300.6, p< .0001], target locations [F(2,48) = 141.61, MSe = 338.0, p< .0001], and an interaction [F(2,48) = 12.28, MSe = 154.4, p< .0001]. The main effect of object presence showed faster RTs when the objects were present (379 ms) than when they were absent (418 ms). The main effect of target locations showed that RTs in the valid condition (363 ms) was faster than those in the invalid-same condition (414 ms) and in the invalid-different condition (419 ms).

For the interaction effect, multiple paired comparisons were conducted for each of the two object presence conditions (object presence and absence). When objects were present throughout the trial, all paired comparisons were significant. The significant RT difference (10 ms; p = .004, η_p^2 =.297) between the invalid-same and invalid-different conditions indicated a same-object effect. When the objects were absent in the target frame, all pairs, but the difference between invalid-same and invalid-different conditions, were significant. The non-significant RT difference between the invalid-same and invalid-different conditions showed the absence of object effect ($p = .884$, $\eta_p^2 = .001$). Similar to those in Experiment 3A, the results showed that the same-object effect was found when the objects were present, but not when the objects were absent in the target frame.

Comparisons across Experiments 3A and 3B

We also conducted a three-way ANOVA for RTs of object presence probability (20% or 80%) by object presence (presence or absence) by target location (valid, invalid-same, or invalid-different location), where the object presence probability is a between-subject factor and the other two factors were within-subject. The main effects of object presence [$F(1,48) = 121.94$, MSe = 339.9, $p < .0001$] and target location [$F(2,96) = 250.78$, MSe = 290.7, $p < .0001$] were significant. That is, RTs were faster when the objects were present than when they were absent. Target detection was faster when the target was at the valid location than at the invalid-same and invalid-different locations. No main effect of object presence probability was found. For our main purpose here, we analyze the interaction of object presence x target location The simple main effects showed that when the objects were present, all paired comparisons were significant (all p's < .0001). The significant RT difference (10 ms) between the invalid-same and invalid-different locations indicated a same-object effect. When the objects were absent, all pairs, but the difference between invalid-same and invalid-different conditions, were significant (all p's < .0001). The non-significant RT difference between the invalid-same and invalid-different conditions showed the absence of the same-object effect (RT difference = 2 ms, $p = .477$, $\eta_p^2 = .01$). These results indicate that regardless of probability manipulation, the occurrence of the same-object effect was associated with the presence of objects in the target frame. That is, the same-object effect was found when there were objects; when the objects were absent in the target frame, even though they were cued and selected previously, the same-object effects were negligible.

In Experiments 3A and 3B, the rectangles disappeared in the target frame in some proportion of trials. We found that the across-trial expectation and the within-trial experience of seeing the rectangles did not influence attentional control on the final empty display that was previously occupied by the rectangles. When the rectangles disappeared in the target frame, the attentional resources on the cued and presumably attended rectangle that was directed by the exogenous cue may be “released” from that rectangle quickly. In other words, when an object disappears, there is no object in the representation upon which attention can focus (Miller, 1989).

Experiment 4A: 80% boomerang presence probability in the target frame

In the previous four experiments, the same-object effects were absent when the rectangles disappeared in the target frame. In other words, the within-trial experience of seeing the objects (the rectangles) had little effects on object-based attention when the object input was truncated suddenly. On the other hand, however, it has been suggested that experiencing seeing *the other* object before the target frame is one of the top-down constraints of object-based attention (Chen, 1998; Zemel, Behrmann, Mozer, & Bavelier, 2002), and therefore it is likely that experience of seeing the objects has an effect on the target detection only when there is object input (although different) in the target frame. To test this, in the next series of experiments, the attended object was replaced with another object in the target display and we examined how the experience of having attended to the original objects and seeing a different object interplay to determine object-based attention. Possibly, the experience of seeing the object on object-based attention is more effective when the bottom-up object input continues to be present.

We used, in the target frame, a boomerang to replace the original rectangles in a certain proportion of trials and manipulated the presence probability of the boomerang. In some trials, the rectangles were present throughout the trial. In other trials, a boomerang appeared in the target frame to interrupt the continuous presence of the two rectangles. Unlike the previous experiments, there were always objects (two rectangles or a boomerang) appearing in the target frame in this and the following experiments.

Method

Participants

Thirty-two undergraduates of the National Taiwan University, with normal or corrected-to-normal vision, served as participants in this experiment in exchange for course credit.

Design and procedure

The rectangles appeared in the target frame in 20% of trials (120 trials, including 76 valid, 24 invalid, and 20 catch trials) and the boomerang appeared in the rest 80% of trials (480 trials, including 304 valid, 96 invalid, and 80 catch trials). If it was the boomerang in the target frame, the invalid-same target location means that the target appears at the corner of the boomerang, and the invalid-different target location means that the target appears at the equidistant location out of the boomerang (Figure 4). The size of the boomerang is similar to the two sides of the large imagery square formed by the two rectangles. The same boomerang presence probability (80%) was applied in the practice trials (6 rectangles trials and 24 boomerang trials).

In the trials with the boomerang appearing in the target frame, the orientation of the boomerang changed with the cue location. Figure 4 showed the cue location, the corresponding boomerang orientation, and the target location. For example, when the cue flashed on the upper end of the left rectangle, the ㄱ-shaped boomerang (Figure 4A) would be present in the target frame to make attention most likely shift along the boomerang contour to the upper-right corner of the boomerang.

Results and discussion

The false alarm rate was 3 % and there was no miss rate. The same exclusion criteria resulted in removal of 1.8 % of the trials. Results of Experiments 4A and 4B are shown in Figure 5. A two-way ANOVA of object type (rectangles or boomerang in the target frame) by target locations (valid, invalid-same, or invalid-different locations) for RTs showed a significant main effect of the target locations [$F(2,62) = 47.84$, MSe = 648.2, $p< .0001$]. The main effect of the target locations showed that RTs in the valid condition was faster than those in the invalid-same condition, and faster than those in the invalid-different condition. The main effects of object type was not significant [$F(1,31) = 2.90$, MSe = 518.4, $p=.098$], indicating no RT difference between the conditions when the rectangles appeared through the trial and when the boomerang appeared in the target frame.

For the interaction effect [$F(2,62) = 10.30$, MSe = 339.5, $p< .0001$], the multiple paired comparisons were conducted for each of two object type conditions (rectangles and boomerang). When the boomerang appeared in the target frame, all the paired comparisons were significantly different, showing the faster responses in the valid condition, and slowest responses in the invalid-different location. That is, when the boomerang appeared, the same-object effect was obtained: Detection of a target on the boomerang (at the invalid-same location) was faster than that on an equidistant location out of the boomerang (at the invalid-different location). The existence of this same-object effect when the boomerang appeared in the target frame indicated that they were not affected by the experience of previewing the rectangles before.

However, when the rectangles continued to appear throughout the trials, no RT difference between the invalid-same and invalid-different target locations was obtained ($p = .311$, $\eta_p^2 = .033$; mean RT difference = 7 ms), showing no same-object effect. This result was different from Experiments 1, 3A and 3B in which the same-object effects were obtained only when the rectangles continue to appear in the trial, compared to when an empty space was shown in the target frame.

Experiment 4B: 20% boomerang presence probability

We decreased the presence probability of the boomerang to 20% and examined whether the same-object effect would reappear. It is possible that when the expectation on boomerang presence decreases, the across-trial experience of seeing the boomerang may be less likely to influence attentional control when the rectangles continued to appear throughout the trials, causing a same-object effect. This experiment tested this possibility.

Method

Participants

Another group of 32 undergraduates of the National Taiwan University served as participants in this experiment in exchange for course credit.

Design and procedure

The rectangles appeared at the target frame in 80% of trials (480 trials; 304 valid, 96 invalid, and 80 catch trials) and the boomerang appeared in the rest 20% of trials (120 trials; 76 valid, 24 invalid, and 20 catch trials). The same boomerang presence probability (20%) was applied in the practice trials (24 rectangles trials and 6 boomerang trials).

Results and discussion

The false alarm rate was 3 % and the miss rate was 0 %. The same exclusion criteria resulted in removal of 2.5 % of the trials. A two-way ANOVA of object type (rectangles or boomerang) by target locations (valid, invalid-same, or invalid-different locations) for RTs showed a significant main effect of the target locations [$F(2,62) = 78.32$, MSe = 458.1, $p < .0001$], object type [$F(1,31) = 443.09$, MSe = 637.4, $p < .0001$], and an interaction [$F(2,62) = 24.36$, MSe = 358.5, $p < .0001$]. The main effect of the target locations indicated that detection was fastest when the target was at the cued location and slowest when the target was at the invalid-different location. The main effect of the object type showed a slower RT when the boomerang was presented in the target frame.

For the interaction effect, when the boomerang appeared in the target frame, the RTs in all pairs were significantly different, except for the difference between the valid and invalid-same locations ($p > .1$; mean RT difference = 3 ms). That is, when the boomerang appeared, the same-object effect was obtained because there was an RT difference of target detection between the invalid-same location and the invalid-different location. However, when the rectangles continued to appear throughout the trial, only the RTs between the invalid-different and invalid-same target locations were not significantly different ($p > .01$, $\eta_p^2 = .089$; mean RT difference = 6 ms). Again, as Experiment 4A, the results showed an absence of the same-object effect when the rectangles appeared in the target frame.

Comparisons across Experiments 4A and 4B

Further, we conducted a three-way ANOVA for RTs of boomerang presence probability (80% or 20%) by object type (boomerang or rectangles) by target locations (valid, invalid-same, or invalid-different locations). The boomerang presence probability is a between-subject factor, and the other two factors are within-subject.

The main effects of boomerang presence [$F(1,62) = 281.33$, MSe = 577.9, $p < .0001$] and target locations [$F(2,124) = 119.74$, MSe = 553.2, $p < .0001$] were significant. When the boomerang appeared in the target frame, the responses were slower than when the rectangles appeared. In addition, target detection was faster when the target was at the cued location than at the invalid-same location, and faster than at the invalid-different location. The three-way interaction was not significant. Two two-way interactions were significant and were analyzed further next.

For the interaction of object type x target location, when the rectangles were present in the target frame, the target detection was fastest in the valid location (376 ms), all *p*'s < .0001. There was no RT difference between the invalid-same (406 ms) and invalid-different (413 ms) target locations, $p = .110$, $\eta_p^2 = .08$, indicating the absence of the same-object effect. On the other hand, when the boomerang was shown in the target frame, target detection was fastest in the valid location (418 ms), slower in the invalid-same location (428 ms), and slowest in the invalid-different location (472 ms), all *p*'s < .008. These results indicate that regardless of probability manipulation, the same-object effect was obtained only when the boomerang, but not rectangles, was present in the target frame.

For the interaction of object type x boomerang presence probability, when the object in the target frame has a higher presentation probability (e.g., 80%), detecting a target on that object is faster. On the other hand, if the object in the target frame has a lower presentation probability (e.g., 20%), target detection on that object is slower. If only the generic grouping principles (the bottom-up constraints) determine the objects of selection, the same-object effects should be observed in the trials in which the rectangles were displayed in the target frame. Nevertheless, our data showed the absence of the same-object effects in this condition, indicating the factor other than the bottom-up constraint that determines the objects of attention. We suggest an important role of the across-trial experience of seeing the boomerang in determining the objects of attention. It is possible that participants can learn the cue-boomerang orientation correspondence in previous trials and this correspondence can influence the online object representations.

In the next two experiments, we further tested the role of the across-trial experience of the boomerang by changing the cue-boomerang orientation correspondence. In Experiments 5A and 5B, the cue-boomerang orientation correspondence was made to restore the same-object effects when the rectangles were in the target frame. That is, the across-trial boomerang orientation was made to facilitate the same-object effects of the rectangles

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Experiment 5A: 80% boomerang presence probability

Method

Participants

Thirty undergraduates of the National Taiwan University served as participants in exchange for course credit.

Design and procedure

The design and procedure were similar to those of Experiment 4A except for the cue-boomerang orientation correspondence. When the boomerang appeared in the target frame, the orientation of the boomerang changed with the cue location. Figure 6 showed the cue location, the corresponding boomerang orientation, and the target location. For example, when the cue flashed on the upper end of the left rectangle, the boomerang became the shape of ∟ in the target frame to make participants' attention most likely shift along the boomerang contour to the lower-left corner of the boomerang (Figure 6A). The trial arrangement was identical to that of Experiment 4A.

Results and discussion

Results of Experiments 5A and 5B are shown in Figure 7. The false alarm rate was 2.3 % and the miss rate was .06 %. The same exclusion criteria resulted in removal of 1.5 % of the trials. A two-way ANOVA of object type (rectangles or boomerang in the target frame) by target locations (valid, invalid-same, or invalid-different locations) for RTs showed a significant main effect of object type [$F(1,29) = 17.21$, MSe = 519.2, $p < .0001$], target locations [$F(2,58) = 98.73$, MSe = 306.1, $p < .0001$], and an interaction [$F(2,58) = 30.98$, MSe = 178..3, $p < .0001$]. When the boomerang was presented in the target frame, a slower RT was obtained. In addition, target detection was fastest when the target was at the cued location and slowest at the invalid-different location.

When the rectangles were presented in the target frame, all paired comparisons were significant (all p's < .01). The significant RT difference (10 ms) between the invalid-same and invalid-different conditions indicated the same-object effect. As we predicted, when the cue-boomerang orientation correspondence was made to restore the same-object effect, the top-down experience of seeing the boomerang did influence object-based attention. As a result, the same-object effect that was absent in the Experiment 4 reappeared in the current experiment.

When the boomerang appeared in the target frame, all paired comparisons reached significant differences as well (all p's < .0001). The fastest responses were observed in the valid condition, and the slowest responses in the invalid-different location. Similar to Experiments 4A and 4B, when the boomerang appeared, the same-object effect was obtained. Parallel to Experiments 4A and 4B, the presence probability of the boomerang in the next experiment was decreased to 20% to examine whether the same-object effect would reappear as well.

Experiment 5B: 20% boomerang presence probability

Method

Participants

Twenty undergraduates of the National Taiwan University served as participants in exchange for course credit.

Design and procedure

The cue-boomerang orientation correspondence was identical to that of Experiment 5A, and the trial arrangement was identical to that of Experiment 4B.

Results and discussion

The false alarm rate was 3 % and the miss rate was 1 %. The same exclusion criteria resulted in removal of 2.8 % of the trials. A two-way ANOVA of object type (rectangles or boomerang) by target locations (valid, invalid-same, or invalid-different locations) for RTs showed a significant main effect of object type [$F(1,19) = 259.00$, MSe = 656.5, $p < .0001$], target locations [$F(2,38) = 99.93$, MSe = 303.7, $p < .0001$], and their interaction [$F(2,38) = 11.27$, MSe = 343..8, $p < .0001$]. The main effect of object type showed a slower RT when the boomerang was presented in the target frame. The main effect of target locations indicate that detection was fastest when the target was at cued location and slowest at the invalid-different location.

When the rectangles were present, all paired comparisons were significant (all *p*'s < .005). The significant RT difference (12 ms) between the invalid-same and invalid-different conditions indicates a same-object effect, same as the results of Experiment 5A. When the boomerang appeared in the target frame, all paired comparisons were also significant (all *p*'s < .0001), showing the fastest responses in the valid condition, and slowest responses in the invalid-different location. Similar to Experiments 4A, 4B, and 5A, when the boomerang appeared, the same-object effects were obtained. These results support our idea that the learned cue-boomerang orientation correspondence plays an important role in determining object-based attention.

Comparisons across Experiments 5A and 5B

A three-way ANOVA for RTs of boomerang presence probability (80% or 20%) by object type (boomerang or rectangles) by target locations (valid, invalid-same, or invalid-different locations) were conducted, with the object presence probability as a between-subject factor. The main effects of object type [$F(1,48) = 250.69$, MSe = 573.6, $p < .0001$] and target locations [$F(2,96) = 196.47$, MSe = 305.1, $p < .0001$] were significant. When the boomerang appeared in the target frame, the responses were slower than when the rectangles were present in the target frame. In addition, the target detection was faster when the target was at cued location than at the invalid-same location, and faster than at the invalid-different location.

The three-way interaction was not significant. Two significant two-way interactions were analyzed further. For the interaction of object type x target location, when the rectangles were presented in the target frame, target detection times in the three possible target locations were significantly different. Target detection was fastest in the valid location (374 ms), slower in the invalid-same location (393 ms), and slowest in the invalid-different location (404 ms), all *p*'s < .0001. The RT difference between the invalid-same and invalid-different locations (11 ms) indicated the same-object effect.

When the boomerang was in the target frame, target detection was fastest in the valid condition (395 ms), slower in the invalid-same condition (428 ms), and slowest in the invalid-different condition (463 ms), all *p*'s < .0001. That is, regardless of probability manipulation, the same-object effect was obtained when the boomerang was presented in the target frame. When the boomerang suddenly replaced the rectangles in the target frame, this sudden onset may involuntarily capture attention (Folk & Remington, 1999; Gellatly & Cole, 2000; Yantis & Egeth, 1999), causing the occurrence of same-object effect. The absence of the same-object effect in Experiment 4 and the presence of it in Experiment 5 provide strong evidence for across-trial expectation of boomerang orientation on attentional control when in fact it was the rectangles that were shown in the scene. Figure 8 showed the mean RT differences and effect size (η_p^2) between invalid-same and invalid-different target locations when the rectangles were in the target frame in Experiments 4 and 5. We manipulated the cue-boomerang orientation correspondence in opposite ways in Experiments 4 and 5 in order to reduce (Experiment 4) or facilitate (Experiment 5) the same-object effects when the rectangles were in the target frame. In both experiments, the occurrence of the same-object effects when the rectangles were in the target frame was affected by the way we manipulated.

For the interaction of object type x boomerang presence probability, the presentation probability of the object in the target frame influences the target detection time when the target appears on that object. When the boomerang was more likely to appear in the target frame (e.g., 80% boomerang presence), detecting a target was faster than when the boomerang appeared less likely in the target frame (e.g., 20% boomerang presence). Similarly, when the rectangles appeared more likely in the target frame (e.g., 20% boomerang presence), target detection was faster than when the rectangles appeared less likely in the target frame (e.g., 80% boomerang presence).

General Discussion

Three important findings are obtained in this study. First, the instantaneous object inputs are critical for the occurrence of the same-object effect. In the first series of experiments (Experiments 1 to 3), we obtained the same-object effect only when the rectangles were present in the target frame, and the *within-trial experience* of having seen the rectangles did not have any effects on the same-object effect. Also, our second series of experiments (Experiments 4 and 5) showed that when the boomerang appeared suddenly in the target frame, the same-object effects were always obtained, not affected by the within-trial experience of seeing the replaced rectangles previously as well. These results suggest that when the activated object (the cued rectangle) is disrupted (e.g., a sudden removal or replacement from a scene), attention could not select the previously cued object location. Namely, once the objects are suddenly removed (Experiments 1 to 3) or replaced with a different object (Experiments 4 and 5), attention is directed to the previously attended object location less efficiently, leading to no same-object effect. This finding seems contradictory to that of Lamy and Tsal (2000, Experiment 1). They reported that when the continuity of the activated object is disrupted (e.g., the cued object swaps suddenly with the uncued object), attention could still select the previously cued object locations.

In Lamy and Tsal's study, the objects (one rectangle and one hourglass) in the target frame were always identical in shapes to those presented in the prior frames. In our study, in the target frame, the rectangles could be either removed or replaced with a boomerang. This dissimilar display (e.g., a blank display or with a boomerang on it) in the target frame in our study may render the target detection on the previously cued object location ineffective in the following ways. When the rectangles in the target frame were removed, the feedback pathways from higher cortical levels guide attention less efficiently. The appearance of the objects in the target frame provides the visual system with the instantaneous and detailed properties (e.g., orientation, contour, color, position and so on; see Cave & Batty, 2006 for a review) of the external inputs, transferred up to the higher cortical levels (Posner & Raichle, 1994). The top-down processes access those at lower levels (Ahissar & Hochstein, 2004) in terms of the current goal and experience. Lacking the instantaneous object input would make the feedback pathways from higher cortical levels guide attention less efficiently. The sudden onset of a target (a gray square) in the empty space may also immediately capture attention (e.g., Yantis, 1993). As a result, without the constraint of the objects (e.g., uniform connectedness and closure in our study), a sudden target onset in a blank display that captures attention causes the absence of the same-object effects. Furthermore, the sudden onset of the boomerang may capture attention involuntarily, indicating a bottom-up constraint (e.g., Folk & Remington, 1999; Gellatly & Cole, 2000; Yantis & Egeth, 1999). When the boomerang suddenly replaced the rectangles in the target frame, the boomerang onset involuntarily captured attention; thus, the same-object effect was always obtained.

The second finding is that *across-trial experience* plays an important role in object-based attention. In Experiments 4A, 4B, 5A and 5B, the rectangles were replaced with the boomerang in either 80% (Experiments 4A and 5A) or 20% (Experiments 4B and 5B) of trials. The boomerang orientated with the cue location in order to reduce (Experiments 4A and 4B) or facilitate (Experiments 5A and 5B) the same-object effects when the rectangles persisted in the display. We showed that the across-trial experience of having seen the boomerang could influence (i.e., reduce or facilitate) the same-object effects when the rectangles were shown in the target frame. Note that we did not exclude the possibility that bottom-up constraints (e.g. the uniform connectedness and closure of the rectangles) also play some role. In Experiments 4A and 4B, the orientation of the boomerang was manipulated so that when the rectangles persisted, attention tended to shift to the invalid location in the uncued rectangle rather than in the cued one. Had the rectangles not contributed to attentional control, the target detection time should have been faster when the target was in the uncued rectangle than in the equidistant cued rectangle. That is, if the rectangles could be completely excluded from attentional control, we should have obtained the "different"-object effects. However, our results indicated the comparable target detection times when the invalidly cued target was in the uncued and the cued rectangle. The orientation of the rectangles in the display and the orientation of the boomerang in the memory system guide attention in opposite directions, canceling out the same-object effects. The fast-acting and default rectangles inputs (Shomstein & Yantis, 2004) and the deliberate boomerang representation in memory (Downing, 2000; Olivers, Meijer, & Theeuwes, 2006; Pratt & Hommel, 2003; Tipper, Grison, & Kessler, 2003) contribute together to attentional control, resulting in the absence of the same-object effect.

The first and second findings implicate that the effects of the top-down constraints (i.e., the experience of seeing the objects) may depend on whether the attended object inputs continue to present. When the continuity of attended object input is disrupted (e.g., a sudden disappearance or replacement), the top-down constraint (the within-trial experience) is less effective as our first finding indicates. When the continuity of attended object input is maintained (e.g., in second series of experiments, the rectangles persist in some portion of trials), the effect of the top-down constraint (the across-trial experience of having seen the boomerang) could influence the same-object effect as the second finding indicates. The sudden change of the attended object input may direct attention to such change, resulting in the ineffective top-down constraint. Further study is needed to examine the interplay between the continuity of the object input and the top-down constraint.

The third finding is that the *expectation on object presence* (i.e., the manipulated probability) was ineffective on the occurrence of the same-object effect. In the first series of experiments, the same-object effect was obtained only with the presence of the rectangles in the target frame, regardless of their presence probability. In the second series of experiments, when the boomerang was shown in the target frame, the same-object effect was always obtained. Possibly, the sudden change (a removal of the rectangles in first series or appearance of the boomerang in second series) of the display in the target frame directs attention involuntarily (e.g., Gellatly & Cole, 2000; Yantis & Egeth, 1999), causing the ineffective manipulation of the expectation on object presence.

In contrast, the *expectation on boomerang orientation* affects object-based attention in the predicted direction. When the rectangles were presented in the target frame, the occurrence of the same-object effect was determined by the manipulated orientation of the boomerang, not its presence probability. We found that with the probability of boomerang presence as low as 20% (e.g., Experiments 4B and 5B), the same-object effects when the rectangles were in the target frame were still modulated by the experience of having seen the boomerang. It appears that even when the boomerang presence probability is low, once the trial number is enough for participants to learn the cue-boomerang orientation correspondence, such correspondence could influence attentional control. Perhaps, 20% of boomerang presence probability (120 trials in Experiments 4B and 5B) is enough for participants to learn the cue-boomerang orientation correspondence. Future study could further reduce the boomerang presence probability to examine whether this effects depends on the learning process; once such correspondence is learned, it can influence attentional control.

In summary, the generic grouping principles (the bottom-up constraints; e.g., Palmer, 2002; Palmer & Rock, 1994), the past experience of previewing the other object (the top-down constraints) all together contribute to define the objects for attentional control (Shomstein & Yantis, 2004). The importance of the bottom-up constraints is revealed when the attended object disappears suddenly or when the new object appears abruptly in the target frame. Also, the importance of the top-down constraints is observed when the attended object is (or is expected to be) replaced with a new object.

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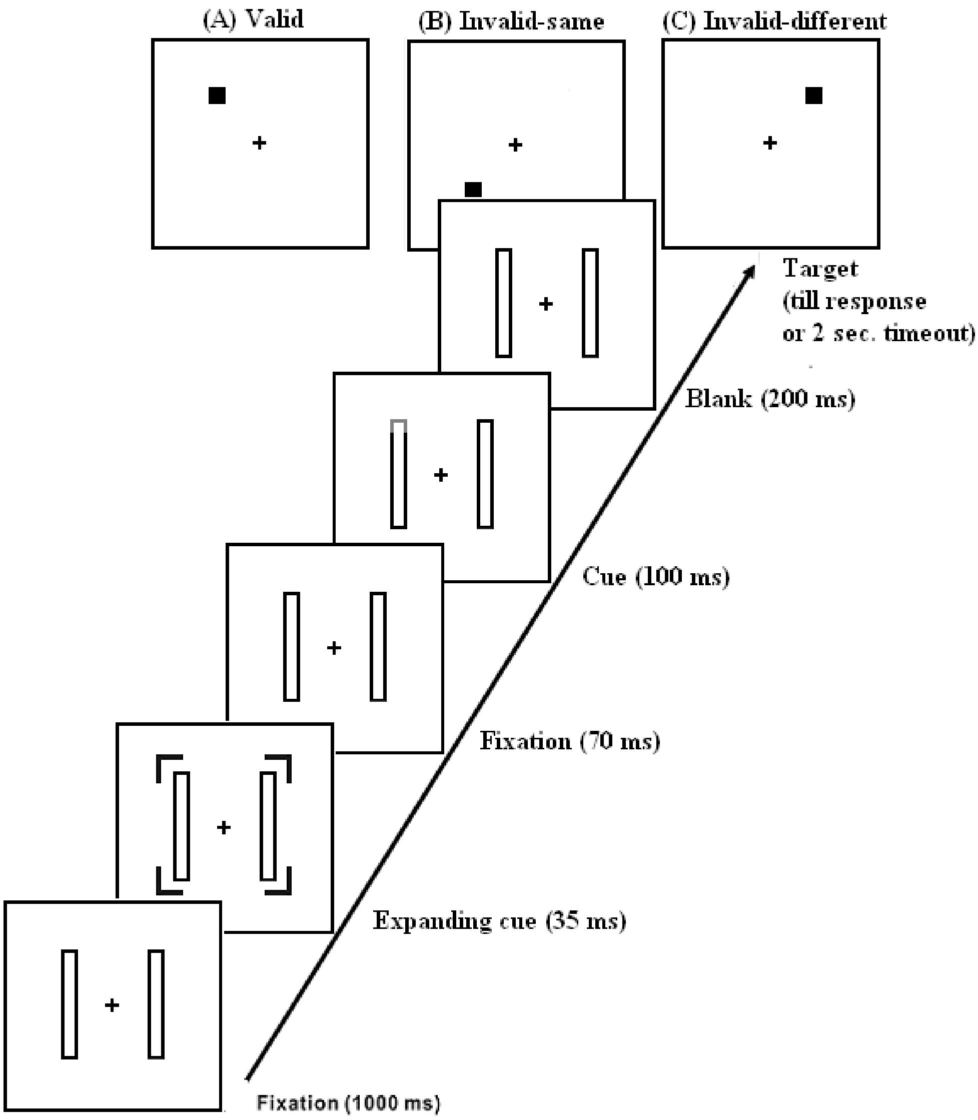

Figure 1. The time sequence of the 0% object presence probability condition in which the objects (the two rectangles) were always absent in the target frame. In the 100% object presence condition, the objects were always present in the target frame. In the 20% and 80% object presence probability conditions, the objects appeared in the target frame in 20% and 80% of trials, respectively.

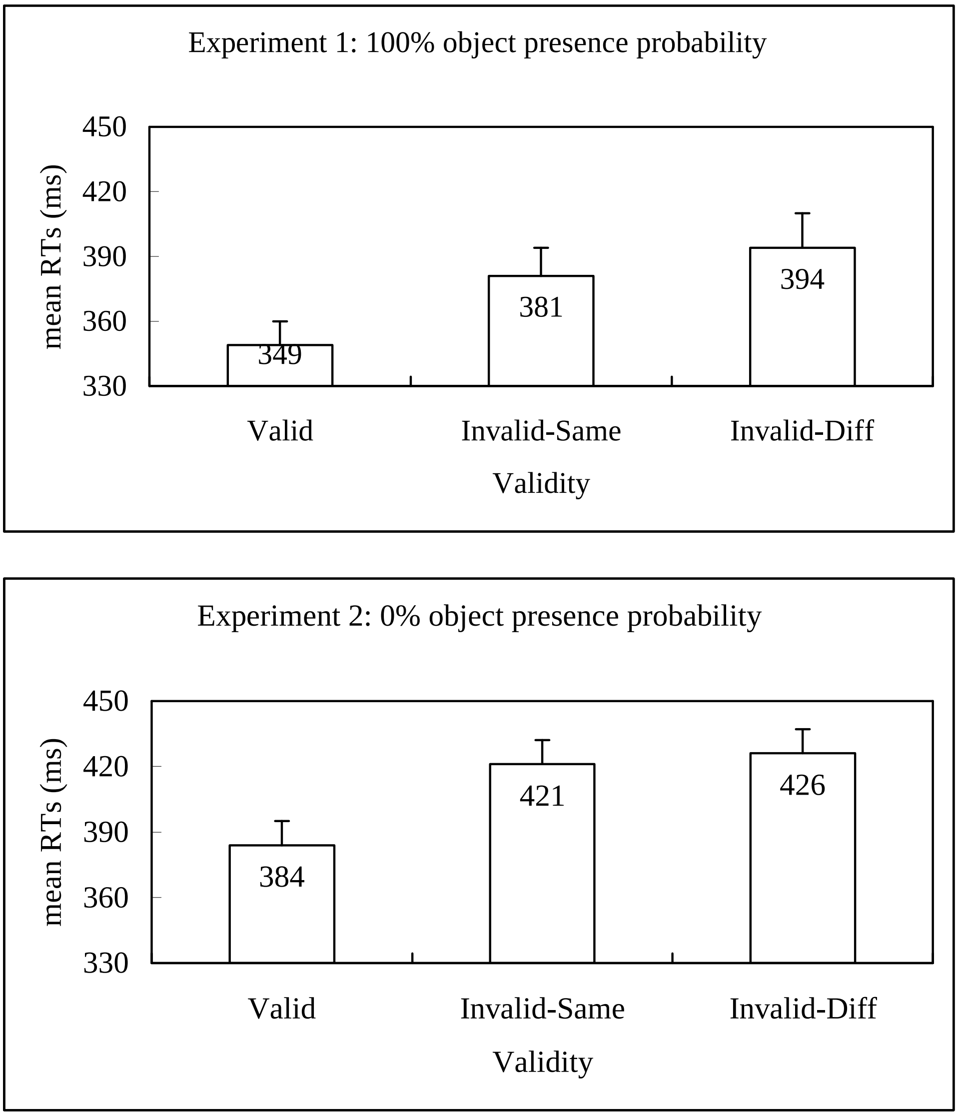

Figure 2. Mean RTs (in ms) and standard error bars in Experiments 1 and 2.

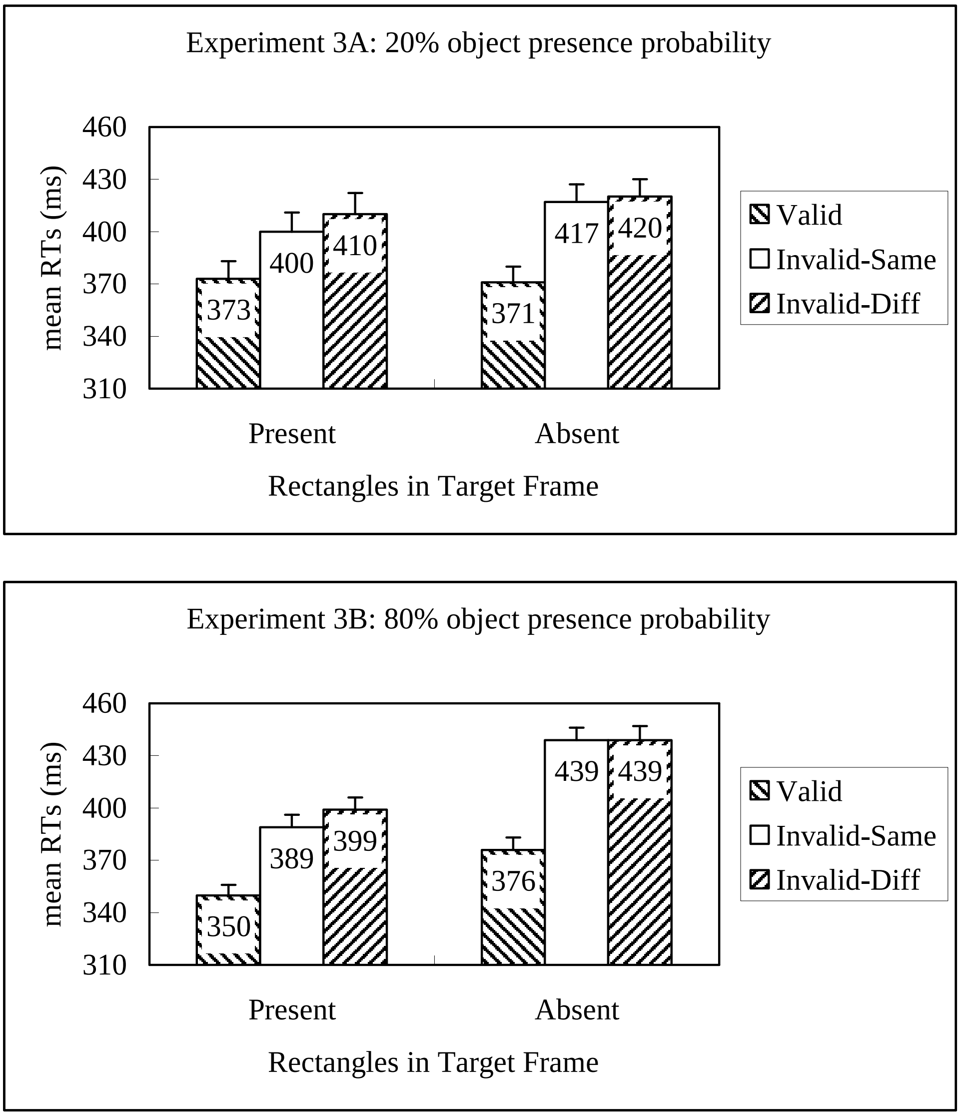

Figure 3. Mean RTs (in ms) and standard error bars in Experiments 3A and 3B.

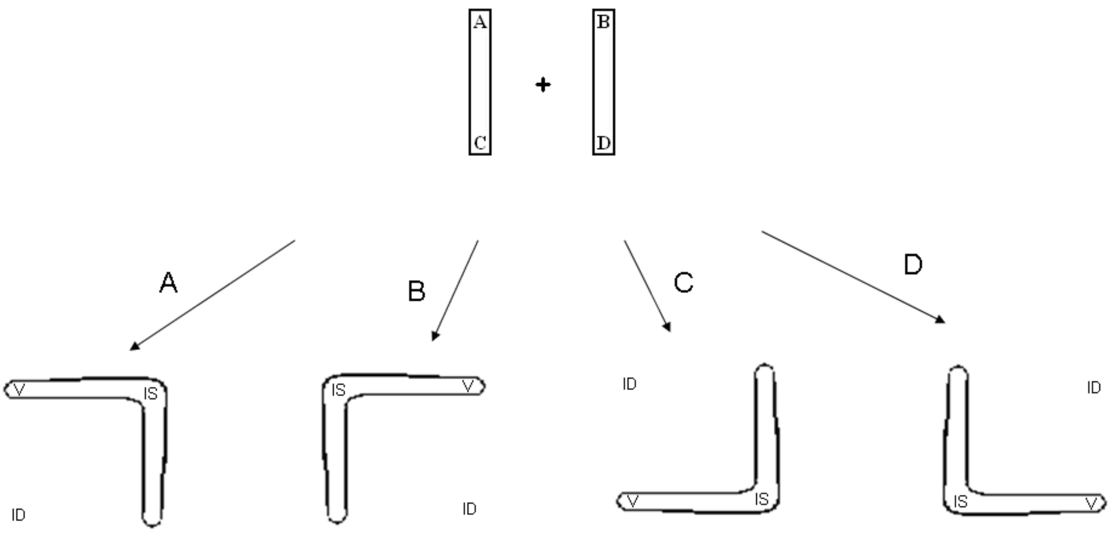

Figure 4. The cue-boomerang orientation correspondence in Experiments 4A and 4B. The cue (not shown) appeared at one of four corners of the rectangles; that is, upper-left (labeled as A), upper-right (labeled as B), lower-left (labeled as C), and lower-right (labeled as D) corners. The orientation of the boomerang changed with the cued corner. For example, when the cue appeared at A, the boomerang orientated as ˥. The target (not shown) could appear at one of three possible locations, as labeled as V (Valid), IS (Invalid-Same) and ID (Invalid-Different).

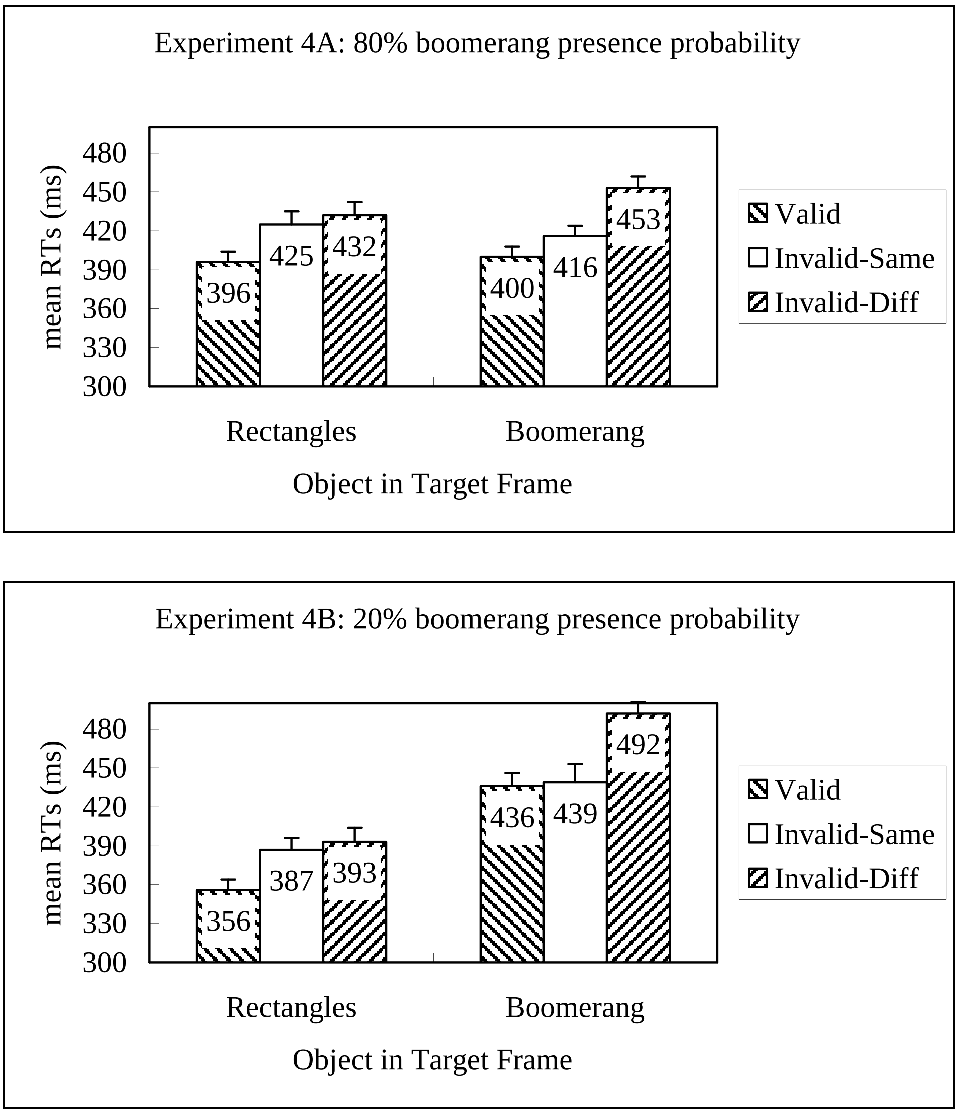

Figure 5. Mean RTs (in ms) and standard error bars in Experiments 4A and 4B.

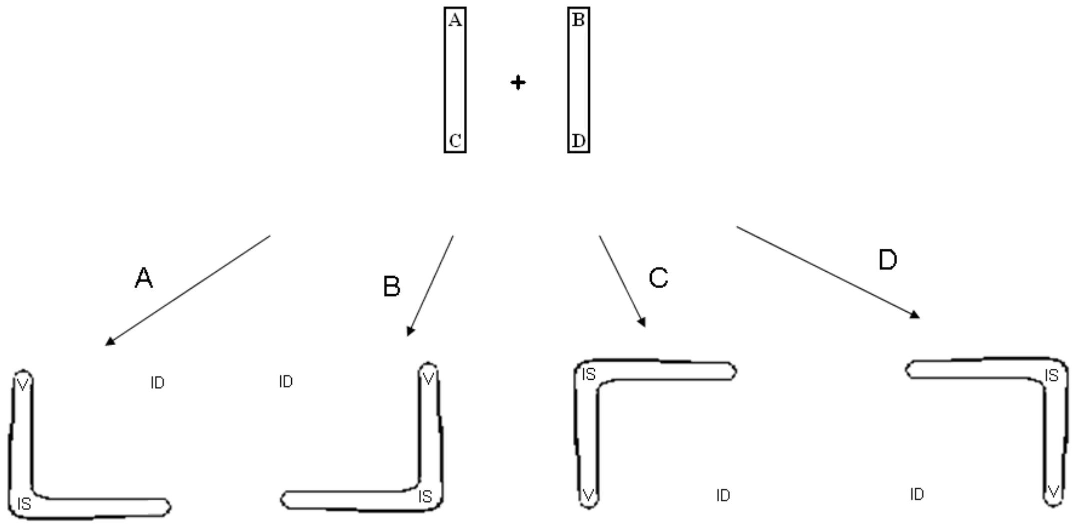

Figure 6. The cue-boomerang orientation correspondence in Experiments 5A and 5B. The cue (not shown) appeared at one of four corners of the rectangles; that is, upper-left (labeled as A), upper-right (labeled as B), lower-left (labeled as C), and lower-right (labeled as D) corners. The orientation of the boomerang changed with the cued corner. For example, when the cue appeared at A, the boomerang orientated as└ . The target (not shown) could appear at one of three possible locations, as labeled as V (Valid), IS (Invalid-Same) and ID (Invalid-Different).

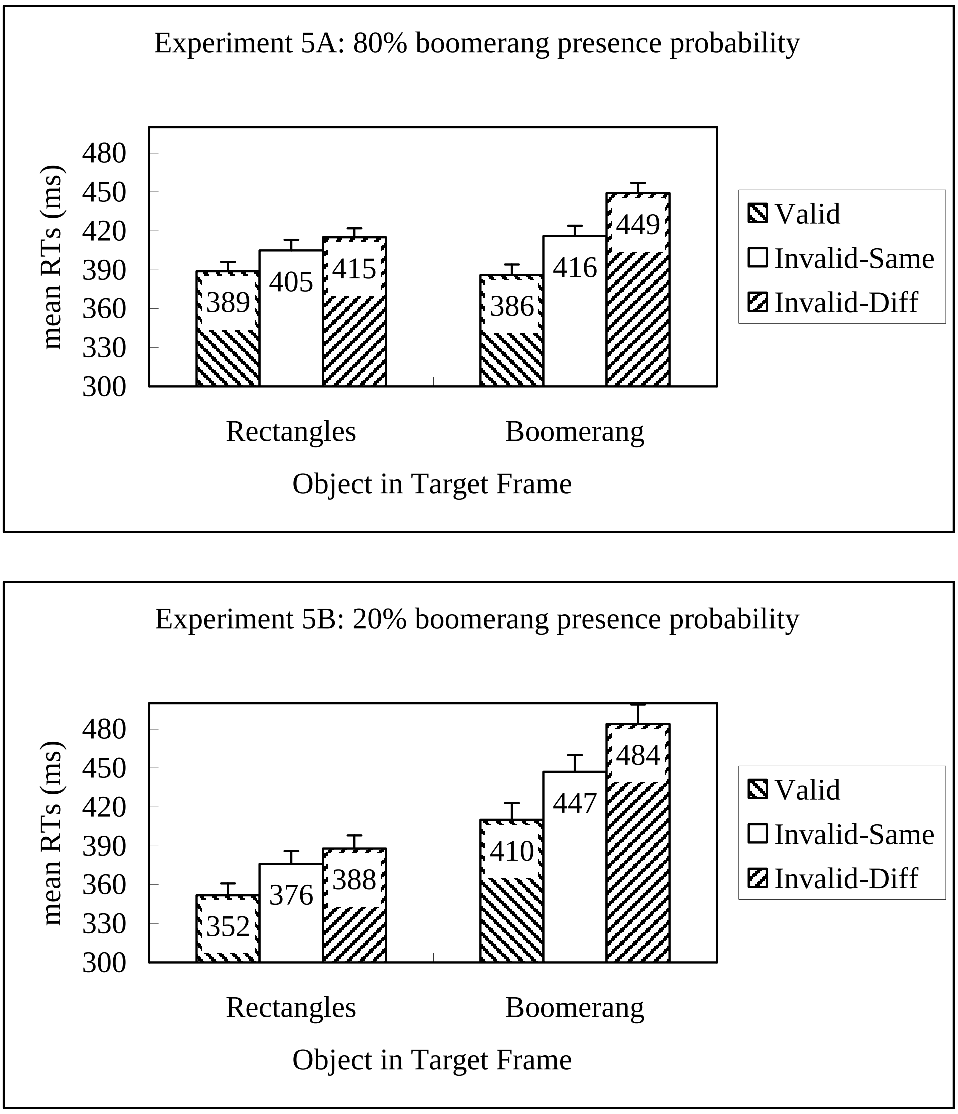

Figure 7. Mean RTs (in ms) and standard error bars in Experiments 5A and 5B.

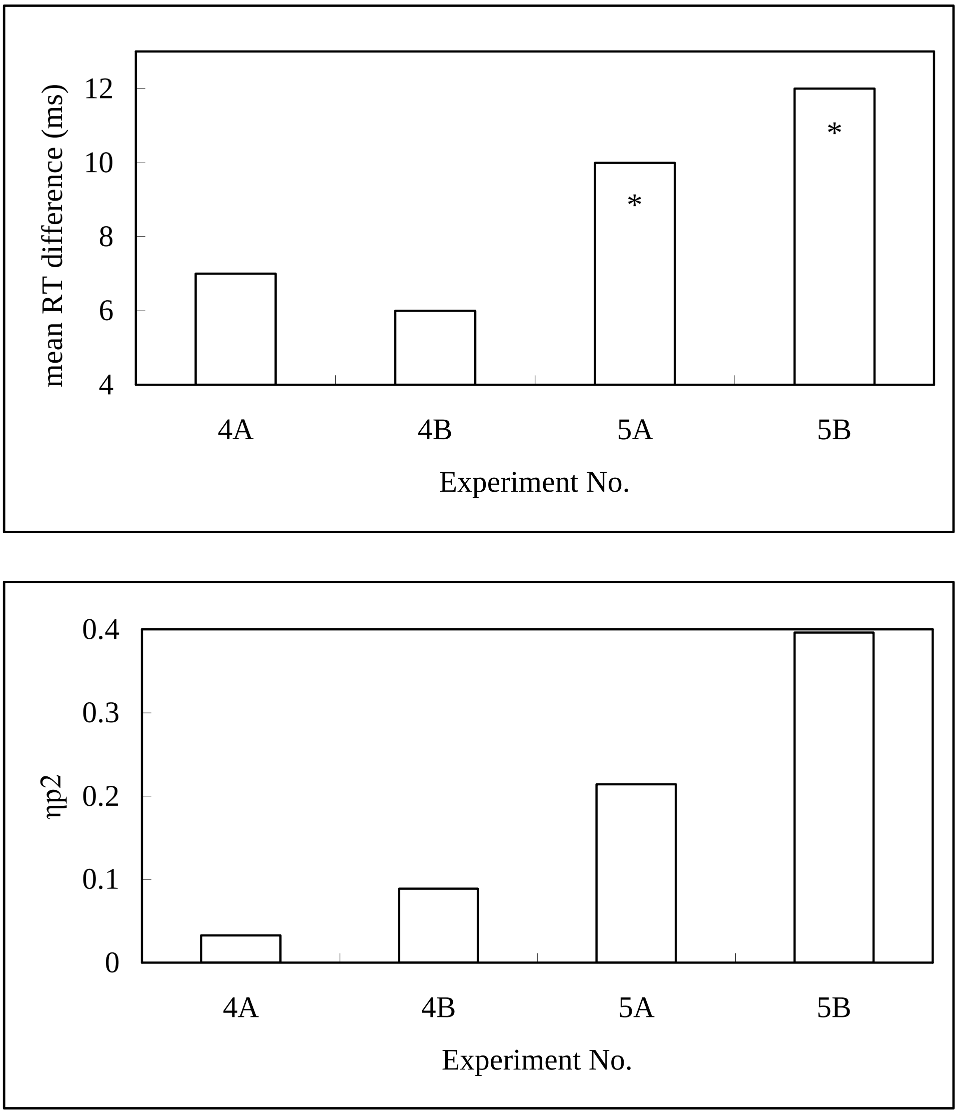

Figure 8. Mean RT differences (top panel) and effect size (η_p^2) between the invalid-same and invalid-different target locations when the rectangles were in the target frame. Asterisks indicate the statistical significance of this RT difference, indicating a same-object effect.

行政院國家科學委員會補助國內專家學者出席國際學術

會議報告

2006 年　9 月　10　日

附件三

報告人姓名	葉素玲	服務機構及職稱	台大心理系教授
會議時間地點	2006 年 8 月 20 日至 8 月 26 日 俄羅斯聖彼得堡 （St. Petersburg, Russia）	本會核定補助文號	
會議名稱	(中文)歐洲視知覺會議 (英文) European Conference on Visual Perception (ECVP2006)		
發表論文題目	(中文) 以漢字筆順探討時空群聚律則與動作知覺的大腦神經機制 (英文) Neural substrates for spatial-temporal grouping and perceived action in the human brain: Evidence from perceived writing sequence of Chinese characters		

參加會議經過與心得

歐洲視知覺會議是歐洲地區最大的視知覺會議，每年選在不同的地區舉行，今年是在跨越歐亞兩大洲、世界上面積最大的國家--俄羅斯--舉行。會議舉行地點在西北部波羅的海沿岸的第二大城聖彼得堡，這個海港城市在西元 1712~1917 年為俄國的首都，為十七世紀末期彼得大帝在瓦涅河口沼澤地上依西歐風格採石頭所建造的城堡，由上百座小島組成，處處可見天然的河流和人工的運河，有「北方的威尼斯」之稱，是俄國通往西方之鑰。此次會議的會場選在 Medical Military Academy Club 舉行，第一天在他們的國家科學院（Academy of Science）開始每年一度的開幕演講，晚上並在河岸另一端的 Menshikoff Palace 舉行歡迎晚會。這次前往俄羅斯，可謂旅途勞頓，由於可搭乘的航班有限，且沒有直飛的班機，一路轉機再加上在法蘭克福的班機延誤，到達下塌的旅館時，已經離出發時間 24 小時之久。

除了第一天下午的開幕演講與歡迎晚會，接下來的五天，議程從早到晚排得滿滿的。每天上、下午共有四場平行的研討會與口頭報告，以及分兩個場地進行的壁

報展。由於場地在軍事單位進行，隨處可見著軍裝的人員在站崗或擔任服務性質的工作。大會的主要負責人 Y. E. Shelepin 並安排了第一天在歡迎晚會以及最後一天閉幕式上由一群軍人吹奏軍樂，連開幕演講的英國學者也配合這種氣氛，講題為「Balls, bullets and shot」，這種濃厚的軍事氣氛，堪稱此次會議的特色。

每年 ECVP 在不同地區舉行時，都會針對地主國的傑出科學家做一專題演講，今年開幕演講邀請英國的 John Mollon（他也是 1978 年 ECVP 的發起人之一），內容是有關俄國凱薩琳大帝時期最出色的俄國學者 Michael Lomonosov。Lomonosov 此人集詩人、文學家與科學家於一身，被尊稱為俄國的科學之父，曾出版第一部俄語文法書，並創辦了莫斯科大學。他是俄國科學院第一位俄籍院士，對光學，力學以及晶體性質的理論研究，影響了俄國的工業發展。除發現能量儲備定律，也證實了金星有大氣存在。至於他在視覺方面的貢獻，則是色彩三色論的首位理論提出者。擔任地主國的好處是可以介紹當國的重要研究者的貢獻，如此次若非在俄羅斯舉行，也許大多數人都不知道 Michael Lomonosov 是色彩三色論的首位理論提出者（教科書版本的介紹都僅指出在其後的 Thomas Young 與 von Helmholtz 的貢獻）。除了開幕演講與地主國的研究者有關，此次大會也特地安排了兩場次的研討會，專門探討制約與知覺學習的關係(Pavlov and Perception)。俄國心理學家 Pavlov 因其所提出的古典制約而著名，然而將制約與知覺連上關係是很新的嘗試，同樣地，若非此次主辦國為俄國，也不會有這類佔了兩場次的新的嘗試出現。有關這點，值得我們思考的是，若在台灣舉行這類型的國際型會議，能夠推出怎樣的代表性人物？

這次會議每天上下午各有四場的研討會與口頭報告，同時分四個場地平行進行，壁報展則在中間休息的時間，上下午各區分單雙號的壁報呈現者在場解說。由於四個場地都有些距離，而且除了最大的演講廳之外，其他三個演講廳入口都在前面，若中間時段插入，不僅視覺上相當引人注目，且演講廳都是年代久遠的木造地板，每一步伐都留下「聽」痕，因此雖然大家一般都是先挑選想聽的場次，若需要則更換不同場次，但這種循常慣用的方式在這次會議中卻不適用。不過這倒也有一好處，在同一類別的研討會中若全部聽完，往往有如參加一場研習營的功能，對該領域的最新研究可以有著通盤的瞭解。當然，其缺點則是：若另外三場中也有想聽的議題，則只能忍痛割捨。

即便已經忍痛割捨了不少很想聽的議題，有趣的是，從頭到尾聽完的演講場次倒也還不少。其中有些是最新的研究領域，邀請的講者都是個中翹楚，聽來相當過癮。例如有幾場是有關時間的知覺，以及將空間知覺的一些概念引用到時間知覺的類比等，這點顯然由於空間視覺的研究到達一定量所累積的成果之後，技術上以及概念上已經可以轉換研究的焦點到時間向度。與此相關的是，大家也漸體認時間與空間這兩個向度應不是分別獨立處理的，因此過去單純只看空間向度的方

式會有所不足，或甚至有誤。就這點而言，與時間空間密切相關的是對物體運動的知覺（motion perception），理由在於能知覺物體在動，必需能登錄在連續的時間點所造成的連續位置改變，此次甚至有研究者指出，過去研究一般都採取靜態圖片單獨呈現的方式來探討人類的空間知覺，但若人類視覺系統根本很少真正處理靜態圖片（考慮動眼與生態效應），且時空二者並非獨立，則由研究單張靜態圖片所導致的結論不僅不完整，甚至可能是不正確的。

這樣的革命性主張，在視覺研究的各個領域都正在以不同形式展現。例如現在認為注意力會影響視覺，而眼動又與注意力息息相關。這類型主動視覺（active vision）的觀點一旦開始被倡導，以前被視覺研究者視為欲控制掉的變項如注意力或眼動，都必需被納入研究的議題中而成為研究的主題之一。另外，社會性大腦(The social brain)的主張，也漸漸使得將個體獨立在實驗室中做無生態效應的操弄之類的研究備受質疑。這次大會也安排了幾場這類型的研討會，整個聽下來，獲益良多。

此次會議註冊的人數逾八百人，共有 766 篇研究報告，在所有與會國中台灣參與的人數排名 21 名，而台灣的學生或博士後得到大會的旅費補助的有兩份。按慣例，在 business meeting 中介紹下次的舉辦地點，以及決定兩年後的地點。下次將在義大利的 Arezzo, Tuscany 舉行，而兩年後有兩個國家提出爭取舉辦國（土耳其與荷蘭），投票多數決的結果，決定在荷蘭舉行。基於此次的經驗，下次將恢復兩個平行的 talks，大家聽了不禁鬆了一口氣。

這次碰到一些學界的朋友，聊起各國家的經費申請問題，感受到基礎研究經費申請吃緊的壓力在世界各地都出現。此外，雖然大家都覺得好的心理物理實驗其重要性絕不亞於大腦造影實驗，但在申請經費的過程往往是後者居關鍵角色。筆者此次其中一份的報告是 fMRI 的研究，有得到一些重要的回饋，對投稿很有幫助。另外，由於我們探討中文字的知覺，也因這獨特性吸引了一些志同道合的研究者前來探問，其中也包括合作研究的可能性，可謂此行的重要收穫。

攜回資料名稱及內容

會議手冊(Abstract book)：
Perception, Volume 35, supplement.

本次會議筆者實驗室所發表的研究成果

Yeh, S. L., Chou, W. L., Lin, S. Y., Chen, D. Y., Chen, J. H., & Chen, C. C. (2006). Neural substrates for spatial-temporal grouping and perceived action in the human brain: Evidence from perceived writing sequence of Chinese characters. *The 29th European Conference on Visual Perception.* St-Petersburg, Russia.

Chen, Y. C., & Yeh, S. L. (2006). Chinese character recognition mediated by sub-morphemic component processing. *The 29th European Conference on Visual Perception.* St-Petersburg, Russia.

Hsu, L. C., Yeh, S. L., & Tang, D. L. (2006). Role of eye movements and attention on temporary blindness and target reappearance. *The 29th European Conference on Visual Perception.* St-Petersburg, Russia.