cuing paradigm and the original findings have been replicated and extended (e.g., Abrams & Law, 2000; Kliegl, Wei, Dambacher, Yan, & Zhou, 2011; Lamy & Egeth, 2002; Lamy & Tsal, 2000; Marrara & Moore, 2003; McCarley, Kramer, & Peterson, 2002; Moore & Fulton, 2005; Moore, Yantis, & Vaughan, 1998; Mortier, Donk, & Theeuwes, 2003; Pratt & Sekuler, 2001; Shomstein & Yantis, 2004). An important extension was made by Li and Logan (2008) who presented four Chinese characters around the fixation and cued one position with a color on a character. In the invalid cue conditions, responses were faster when the target character and the cue character formed a compound word than whey they did not. This effect was interpreted as indicating that objects can be defined in a top-down fashion based on lexical organization and these lexical-based objects can constrain attention deployment in the same way as perceptual-based objects. A recent study by Chen and Zhou (2011) also showed that perception of visual apparent motion can be modulated by a task-irrelevant, lexical-based object. The authors presented participants with two suc-

The distance between the centers of two adjacent characters was 1.6° of visual angle. The distance between the center of a character and the fixation sign was 1.13° of visual angle. For the purpose of rejecting trials on which participants looked away from the fixation cross, eye movements were recorded (at a 2000 Hz sampling rate) using an EyeLink 2K system. All the characters were shown in black against a gray background. The fi

the "invalid same word condition), attentional shift was then from the second character to the first character, inconsistent with the direction of normal eye movement or attentional shift in reading. Nev-

characters forming the set of compounds were randomly combined to

object than on a perceptual-based object. Both experiments also found an object effect, with faster responses to the "invalid same object" trials than to the "invalid different objects" trials. Importantly, in both experiments this object effect was of equivalent magnitude for the three types of stimuli: it was all of equal size to the effect for compound words presented alone.

The finding of object effects for all the types of stimuli suggests that attention shift is more efficient within an object than between objects, whether the object is defined in terms of lexical organization or in terms of Gestalt principles. However, the finding of equivalent effects for both the congruent and incongruent trials is perhaps surprising, given that the lexical-based and perceptual-based objects can independently produce effects during attention deployment. Intuitively, these effects should be able to cancel each other when they are in conflict and should be added up when they are congruent. A possible account for the overall pattern of the effects is that the cognitive processes underlying the two types of object effects interact with each other and this interaction does not produce an effect larger or smaller than the effect produced by the lexically or perceptually defined object alone.

An alternative account is that the processing system may rely on one type of object structure to constrain attention deployment while ignoring the other type. Thus for the "compound only" trials, the lexically defined object guided attentional shift; for the "rectangle with nonwords" trials, the perceptually defined object guided attentional shift. For the "congruent" and "incongruent" trials, however, it was the lexically rather than perceptually defined object that played an upper hand in constraining attentional shift.

One might wonder why the system should or could ignore the constraints from the rectangles, especially for the congruent trials. Note that we were careful to color the end of the rectangle surrounding the cue or target character simultaneously and the representations for both the lexical object and the perceptual object should be activated by the cue or the target. We suspect that the absence of modulation by the congruency between the two types of objects was due to the blocked presentation of different types of stimuli. In blocked presentation, the system could actively keep the activated lexical representations of compound words in working memory and use them to guide subsequent attentional shift. However, lexical representations and the rectangles were perceived as separate objects even though they were activated simultaneously. Constraints from the perceptual structure of the rectangles were strategically and actively suppressed during the shift of attentional focus from the cue character to the target character. This suppression was relatively easy given that in a test block the displays of characters and rectangles were essentially the same across trials and the same strategy can be applied to different trials.

If, however, different types of stimuli are randomly mixed, the system may be less able to suppress the constraints of rectangles on attentional shift and the overall object effect could be modulated by the congruency between the two types of objects. This possibility was tested in Experiment 3B.

4. Experiments 3A and 3B

In Experiments 2A and 2B, congruent trials and incongruent trials were tested separately. In Experiment 3A, we included the two types of stimuli in the same experiment to replicate the absence of congruency modulation in blocked presentation. Experiment 3B used the stimuli as Experiment 3A but with different types of stimuli randomly mixed. If the absence of modulation by the congruency between the two types of objects was indeed due to strategic adjustment of the processing system in face of blocked presentation, mixing stimuli randomly could effectively reduce the active suppression of the perceptual object, and the impact of congruency on the overall object effect could then be revealed.

4.1. Method

4.1.1. Participants

Twenty graduate and undergraduate students from Peking University and 20 students from Shaanxi Normal University were tested respectively for Experiments 3A and 3B. All of them were right-handed and had normal or corrected-to-normal vision. None of them had taken part in the previous experiments.

4.1.2. Design and materials

In each experiment, a 2 (stimulus type: congruent, incongruent) × 3 (cue validity: valid, invalid same object, invalid different objects) within-subjects factorial design was used. The definitions of stimulus type and cue validity were the same as in Experiments 2A and 2B. The word pairs were taken from those used in Experiments 2A and 2B. The assignment of stimuli into the congruent and incongruent conditions was counter-balanced over participants. There were 592 trials in total, with 512 critical trials having a color target and 80 catch trials without the target. For the critical trials, there were 256 (50%) valid trials and 128 trials (25%) for each of the two invalid conditions. Half of the trials were for the congruent condition and another half for the incongruent condition. The congruent and incongruent trials were presented in different blocks in Experiment 3A and were counter-balanced in order over participants, with the valid, "invalid same object", and "invalid different objects" trials being randomly mixed and being divided into 4 blocks of 74 trials each. In Experiment 3B, the "congruent" and "incongruent" trials were randomly mixed. Other aspects of stimulus preparation and experimental procedures were the same as in Experiments 2A and 2B.

4.2. Results

A similar ANOVA for RTs in Experiment 3B did not find a significant main effect of stimulus type, $F(1,19) = 0.73$, $p = 0.40$, η_p^2

rectangle helped the system to focus on characters than on the outlines of rectangles. Moreover, the activated semantic representations of compound words help to keep the visual structure (the layout) of the compounds in working memory, guiding subsequent attentional shift from the cue character to the target character. It is no wonder that the processing system is predominantly influenced by constraints of the lexically defined object in shifting attentional focus: the shift of attention was more efficient along characters forming a compound (i.e., in the "invalid same object condition) than along the rectangle (i.e., in the "invalid different objects condition), producing faster responses to the color target in the former than in the latter. Indeed, the functioning of the lexically defined object overshadowed the potential impact of the perceptually defined object not only when the object structures were incongruent but also when they were congruent: even when the perceptual structure of the rectangles could help to facilitate attentional shift, the object effect was still of the same magnitude as the effect for compound words alone (Experiment 2A).

The suggestion that constraints from the perceptual structure of the rectangles can be strategically suppressed during attentional shift was further supported by the fi