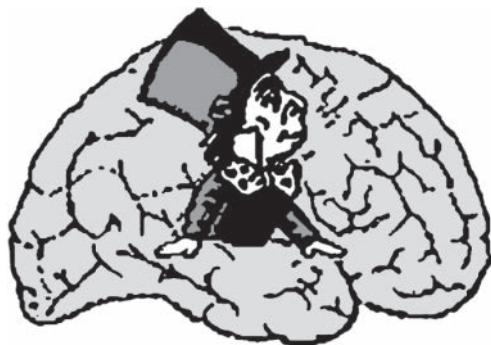


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НОВЫЕ ИССЛЕДОВАНИЯ



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CAN PERCEPTUAL GROUPING BY LUMINANCE SIMILARITY OR BY ELEMENT CONNECTEDNESS TAKE PLACE WITHOUT VISUAL AWARENESS?

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Abstract. Here we examine whether visual awareness is required for perceptual grouping by luminance similarity and element connectedness. Participants were presented with liminal prime stimuli followed by a target. Primes consisted of dot elements grouped into columns or rows by luminance similarity (Experiments 1 and 3) or by element connectedness (Experiments 2 and 4). Luminance similarity and element connectedness primes were rendered invisible separately either by continuous flash suppression (CFS) or by sandwich masking. The targets consisted of lines that could have vertical or horizontal orientation. The orientation of lines in a target could be either congruent or incongruent with the orientation of primes. On each trial, participants made speeded discrimination of the target and then rated the visibility of the prime using a scale ranging from 0 to 3. Unconscious processing of the prime was measured as the priming effect on target discrimination performance on trials in which participants reported not seeing the prime. In the CFS and sandwich masking experiments, priming effects of luminance similarity and element connectedness were found when the prime was reported to be visible. Significant priming effects of luminance similarity and element connectedness were found for visibility rating 0 when the prime was rendered invisible by sandwich masking, but not by CFS.

Keywords: luminance similarity, element connectedness, continuous flash suppression, sandwich masking, visual awareness

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In the current study, we address the question as to whether perceptual grouping can happen without visual awareness. Previous research has demonstrated that grouping by such Gestalt principles as proximity and luminance similarity could produce priming effect when the primes were invisible due to sandwich masking (Montoro et al., 2014). However, in that study the visibility of the prime was measured by means of the forced-choice prime detection task in a separate block. Thus, it is not quite clear whether the primes were invisible in each trial of the masked priming experiments. Other studies examining illusory contour formation without visual awareness yielded inconsistent results (e.g., Harris et al., 2011; Lau, Cheung, 2012; Moors et al., 2015; Wang et al., 2012). The discrepancy in these results can

partly stem from methodological differences such as the participants' task or a particular invisibility inducing technique implemented in a study.

The aim of the research was to examine whether perceptual grouping by luminance similarity (Wertheimer, 1922/1953) in Experiments 1 and 3 and by element connectedness (Palmer, Rock, 1994) in Experiments 2 and 4 can unfold in the absence of visual awareness. To this end, we used a masked priming paradigm in four separate experiments. In the first two experiments, the prime stimuli were rendered invisible by "continuous flash suppression" (CFS; Tsuchiya, Koch, 2005); in the other two experiments the sandwich masking (Breitmeyer, 2015) was used. Unconscious grouping of the prime was measured as the priming effect (of the prime-target congruency) on target discrimination performance on trials in which participants reported no visibility of the prime.

Method

83 participants (66 females; age 19–37, $M=23.4$) had normal or corrected-to-normal vision and participated only in one of the experiments: Exp. 1 ($n=23$), Exp. 2 ($n=19$), Exp. 3 ($n=20$), Exp. 4 ($n=21$).

The prime consisted of dot elements organized either by luminance similarity (Exp. 1 and Exp. 3) or by element connectedness (Exp. 2 and Exp. 4) into columns or rows (see Fig. 1A). The targets consisted of lines that could have vertical or horizontal orientation. The orientation of lines in a target could be either congruent or incongruent with the orientation of primes. The color of targets was irrelevant to the task. In the CFS experiments (1 and 2), participants viewed the stimuli through a mirror stereoscope so that the primes were always presented to the suppressed eye and the colored flashing Mondrian masks were presented to the dominant eye of the participants (see Fig. 1B). The prime-target SOA varied in the CFS experiments: 200 ms, 400 ms, 600 ms, 800 ms. In the sandwich masking experiments (3 and 4), the primes were always presented for 40 ms, and participants viewed stimuli naturally with both eyes (see Fig. 1C). Only a chinrest was used to eliminate head movements in the sandwich masking experiments.

In each trial of an experiment, participants made a speeded discrimination response to the orientation of the target lines and then rated the visibility of the prime from 0 ("I saw nothing") to 3 ("I clearly saw"). The priming effect was measured as the difference in RTs between incongruent and congruent trials.

Results

The percentages of trials for visibility ratings 0/1/2/3 (across SOAs) in CFS were 59/18/14/10 for luminance similarity and 57/14/9/20 for element connectedness experiments correspondingly. The percentages of trials for visibility ratings 0/1/2/3 in sandwich masking were 67/14/11/8 for luminance similarity and 53/28/15/4 for element connectedness experiments correspondingly. For the reason that there were not many trials with visibility ratings 2 or 3, we combined trials with visibility ratings 2 and 3 for each experiment for further analyses. The priming effects for each level of visibility for the four experiments are presented in Fig. 2.

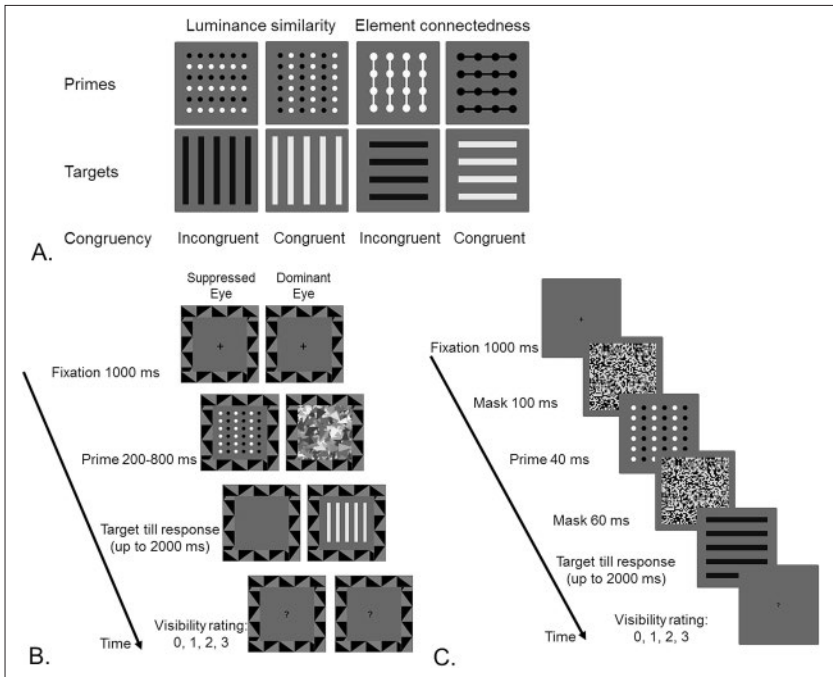


Figure 1. Examples of stimuli (A) and a schematic description of a trial in CFS (B) and sandwich masking (C) experiments.

Discussion and Conclusions

Significant priming effects of grouping by luminance similarity and element connectedness were observed in CFS and sandwich masking experiments when participants were aware of the primes. There is no evidence of grouping by luminance similarity or element connectedness in the absence of visual awareness when the latter is induced by CFS. However, when the stimuli are rendered invisible by sandwich masking, priming effects of luminance similarity and element connectedness can be observed when participants report not seeing the primes. The results of the sandwich masking experiments are consistent with previous findings observed by Montoro and colleagues (Montoro et al., 2014), who found priming effects of luminance similarity and proximity for primes that were invisible due to sandwich masking. Thus, we replicated the results for grouping by luminance similarity in an experiment with improved control of prime visibility and we are the first to demonstrate a similar pattern of results for element connectedness. The difference in unconscious priming effects for the same stimuli between two invisibility inducing methods is intriguing and needs further elaboration through future research. Under the assumption that both techniques induce equal phenomenal states of unawareness, it is reasonable to suggest that different mechanisms

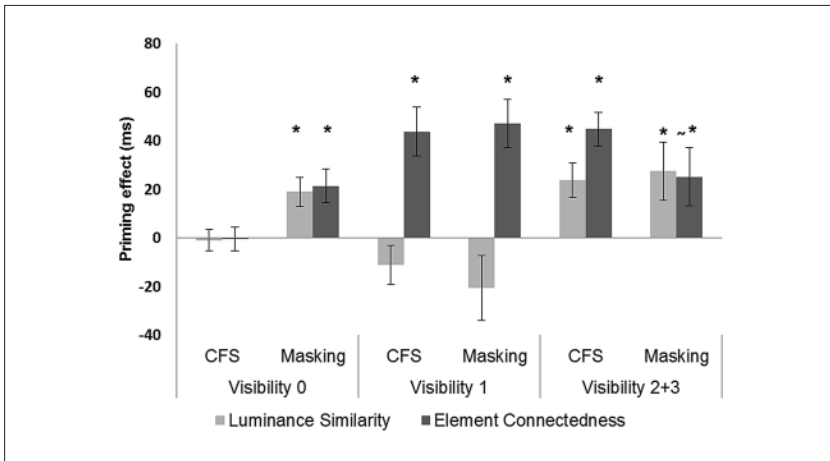


Figure 2. Results of the four experiments: mean priming effects for each level of visibility rating. Error bars represent standard error of the means. Asterisks denote a significant priming effect ($p < .05$), * denotes $p = .0504$.

underlying each invisibility inducing method define the level of processing available for a stimulus. Interestingly, priming effects of luminance similarity and element connectedness in the presence of visual awareness were not significantly greater than the priming effects in the absence of visual awareness induced by sandwich masking. These findings from the sandwich masking experiments suggest that visual awareness is not only unnecessary but also does not improve perceptual grouping by luminance similarity or element connectedness.

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Может ли перцептивная группировка в соответствии с принципами сходства по яркости или соединенности элементов происходить в отсутствии зрительного осознания?

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Аннотация. Исследуется вопрос о необходимости присутствия зрительных стимулов в сознании для процессов перцептивной группировки по принципам яркостного сходства или соединенности элементов. Испытуемым предъявлялся пороговый стимул-прайм, после которого предъявлялся целевой стимул. Прайм состоял из точек, сгруппированных в колонки или строки с помощью сходства по яркости (Эксп. 1,3) или соединенности (Эксп. 2,4) элементов. Для того чтобы оба вида праймов не достигали сознания, в отдельных экспериментах использовалась либо методика «продолжительного подавления вспышкой» (Continuous Flash Suppression; CFS), либо сочетание прямой и обратной маскировки. Целевые стимулы состояли из вертикальных или горизонтальных линий; ориентация линий, составлявших цель, могла быть конгруэнтна или неконгруэнтна ориентации прайма. В каждой пробе испытуемый выполнял задачу категоризации цели и затем оценивал степень видимости прайма по шкале от нуля до трех. Неосознаваемая обработка стимулов в прайме измерялась как влияние прайминга на выполнение задачи категоризации цели в пробах, в которых испытуемые сообщали, что они не видели прайм. Как в экспериментах с CFS, так и в экспериментах с маскировкой эффекты прайминга были получены для обоих типов праймов в пробах, когда испытуемые видели прайм. Эффекты неосознаваемого прайминга, когда испытуемые сообщали, что они не видят прайм, для принципов сходства по яркости и соединенности были получены в экспериментах с маскировкой, но не в экспериментах, где прайм маскировался с помощью CFS.

Ключевые слова: сходство по яркости, соединенность элементов, продолжительное подавление вспышкой, прямая и обратная маскировка, сознание