Priming effects depend on relative stimulus strength during continuous flash suppression

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Research questions

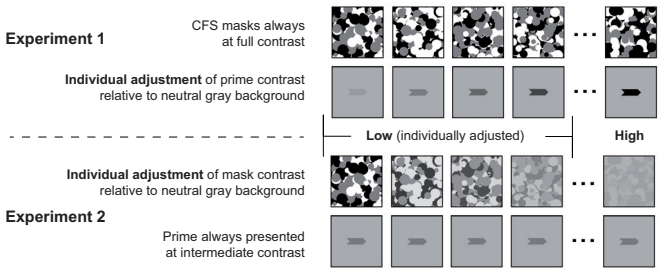
Awareness of a stimulus presented to one eye can be strongly suppressed by continuously flashing pattern masks to the other eye [1]. However, the conditions under which stimuli masked by Continuous Flash Suppression (CFS) can prime behavioral responses to subsequent visible targets are a matter of debate [2, 3]. Research suggests that CFS modulates the gain of neural responses in early visual areas, simlar to reducing the contrast of the masked stimulus [4].

Here, we tested if the stimulus strength of primes relative to CFS masks reliably influences
(Q1) priming of motor responses to subsequent targets, and
(Q2) discriminability of suppressed primes.

We also tested if priming effects increase with higher prime discriminability (Q3).

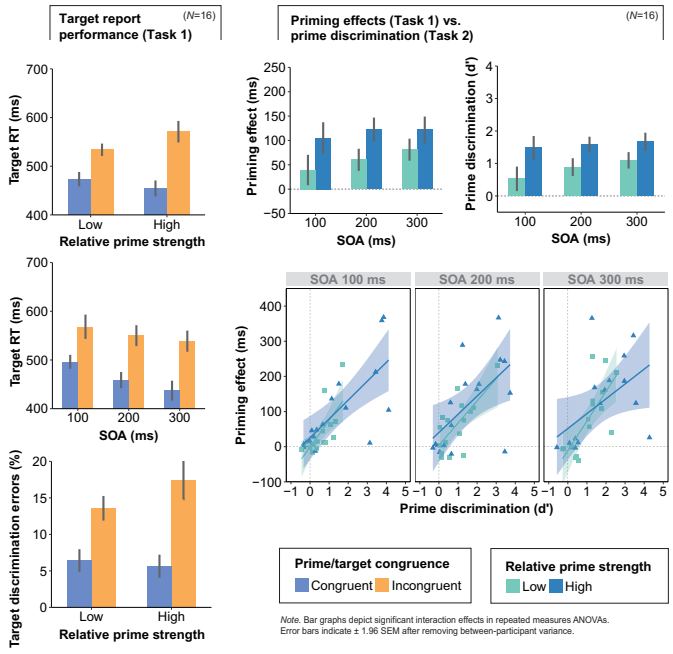
Manipulation of relative prime strength

Using an adaptive staircase experiment at the beginning of each session, prime strength was adjusted to match discrimination tresholds (55% correct) of individual participants.
This "Low" prime strength was contrasted against a "High" prime strength condition which was identical for all participants.



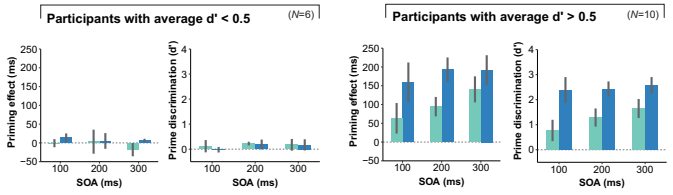
Experiment 1

Target reaction time (RT) and errors were reduced when prime and target where congruent rather than incongruent. This priming effect was larger with high than with low prime strength, where the effect increased with SOA. Individual priming effects varied considerably between participants with a strong linear relationship of prime discrimination and the size of the priming effect:

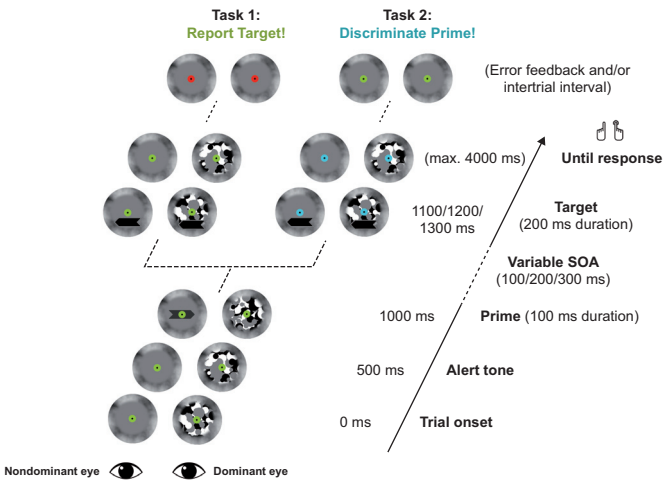


Note. Bar graphs depict significant interaction effects in repeated measures ANOVAs. Error bars indicate ± 1.96 SEM after removing between-participant variance.

Six participants were unable to discriminate the primes even at maximal strength (individual d'<0.5 in the "High" condition). In these participants, priming effects were fully absent:



Dual task procedure

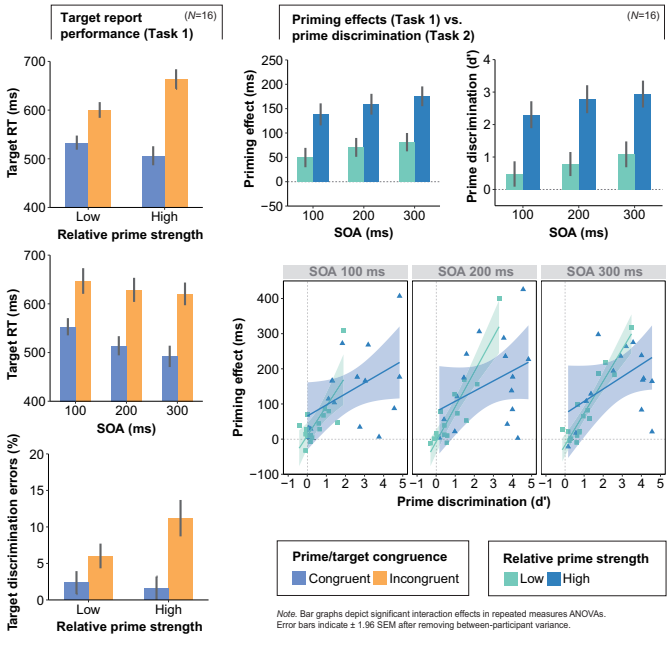


Prime arrows were presented at fixation to the nondominant eye and suppressed from awareness by showing grayscale pattern masks to the dominant eye at a rate 10 Hz. Primes were followed by visible target arrows (above or below fixation, at both eyes) with a variable stimulus onset asynchrony (SOA). Direction of target arrows was congruent or incongruent with primes.

Participants performed two tasks, randomly intermixed across trials. If the fixation cross remained green (Task 1), participants gave speeded manual reports of the target arrow's direction. Whenever the fixation cross changed to blue (Task 2), participants discriminated (or guessed) the prime arrow's direction using the same buttons. In both experiments, each participant completed 768 trials per task across two sessions.

Experiment 2

Findings of Exp. 1 were replicated in a new participant sample. Manipulating prime strength by adjusting mask contrast enabled all participants to discriminate primes in the "High" condition. Again, priming effects clearly depended on prime strength and discriminability.



Note. Bar graphs depict significant interaction effects in repeated measures ANOVAs. Error bars indicate ± 1.96 SEM after removing between-participant variance.

Summary and conclusions

Priming depended on relative prime strength and SOA. We found similar effects on priming and prime discriminability by adjusting prime contrast relative to a constant mask contrast (Exp. 1), and by adjusting mask contrast relative to a constant prime contrast (Exp. 2).

As in classical binocular rivalry [5, 6], stimulus strength seems to be a key determinant of perception and priming during CFS. If relative prime strength is too low, neural signals elicited by the prime at early stages of processing might drown in the sensory noise generated by the mask [cf. 4]. This could prevent the signal of the prime from reaching awareness and influencing behavior. Consequently, the use of CFS for studying visual processing outside of awareness is more limited than, e.g., metacontrast masking [3, 7].

Also, individual differences in priming were strongly associated with prime discrimination. Priming effects were non-significant when participants were fully unaware of primes. Our results therefore stress the importance of sensitive awareness tests in CFS studies on priming.

References

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