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The Transfer of Global and Local Processing Modes

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Förster and Dannenberg's (2010) GLOMO^{sys} theory claims that people process perceived events and internal information in a more global or more local processing mode and that adopted modes should transfer to other, unrelated tasks. If so, global/local processing modes would qualify as metacontrol states that are assumed to regulate processing dilemmas, like persistence/flexibility, exploitation/exploration, or speed/accuracy (Goschke, 2000). Given increasing rates of nonreplications of previously demonstrated far transfer from prime tasks that are likely to induce a particular global or local processing bias to logically and temporally unrelated probe tasks, we tested whether near and far transfer can be demonstrated under conditions that should be optimal for such transfer. We reduced the temporal distance between prime and probe trials by integrating them into a dual-task paradigm and used probe tasks that were either almost identical to the prime task or at least shared the relevant modality and attentional demands. We obtained significant transfer effects between almost identical visual global/local tasks, irrespective of the degree of cognitive conflict that these tasks generated, but did not find any evidence for somewhat farer transfer to other visual tasks, like a flanker task and an attentional blink task. That is, any substantial change in the probe task's characteristics compared with the prime task eliminated almost any signs of transfer. Altogether, we conclude that either global/local processing modes as envisioned by GLOMO^{sys} do not exist or they normally do not transfer from global/local tasks to other, unrelated tasks.

Public Significance Statement
Our study tested whether focusing on global or local aspects of visual stimuli establishes a general information-processing mode that might also affect processing in other, unrelated tasks. We thus constructed experimental designs in which participants carried out two tasks in a row, with the first having them focus on either the global or the local aspects of visual stimuli. This affected information processing in the second task if this task was very similar to the first, but not if it differed. We conclude that either focusing on global or local aspects does not establish a general information-processing mode or this mode does not transfer to sufficiently dissimilar other tasks.

Keywords: global-local processing, GLOMO^{sys}, metacontrol, transfer

One of the key features of human cognition is its adaptivity. Within a few milliseconds, we can establish a particular mindset that enables us to carry out almost any response to any stimulus, depending on the task, the context, and our current goals. This ability is commonly referred to as cognitive control. It comprises functions that allow us to associate any kind of stimulus representation with any kind of response representation, and to make these associations contingent on particular task conditions and contextual requirements (Goschke, 2000). In addition to these associative abilities, humans can also adjust their processing *style*—the way they select stimuli, process information, and choose actions. For instance, we often face and resolve processing dilemmas like stability (or persistence)/flexibility (Goschke, 2000), exploitation/exploration (Cohen et al., 2007), or speed/accuracy. The persistence/flexibility dilemma refers to the fact that, as we live in a rapidly changing environment, a planned or ongoing goal or action can quickly become obsolete or impossible owing to unforeseen circumstances. As a result, too much persistence on the current goals would be counterproductive, which calls for counterforces promoting cognitive flexibility under appropriate circumstances. Indeed, there is evidence that humans can adopt more persistent and more flexible processing modes under different circumstances, an ability that Hommel (2015) has called *metacontrol*. The term is meant to highlight that processing modes

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are not just another control function but regulate, and in a sense control, cognitive control, and determine the style in which cognitive control is exerted. For instance, cognitive control is commonly assumed to comprise functions that make sure that decision-making and the underlying competition between alternative options are sensitive to the present goal (Bogacz, 2007). However, the degree to which alternative options compete and to which goals determine the eventual outcome of a decision has been shown to vary both between individuals (for example, depending on their genetic predisposition regarding genes relevant for dopaminergic processing or their cultural background; Markett et al., 2011; for a review see Hommel et al., 2011) and within individuals (e.g., depending on mood; for a review, see Hommel & Colzato, 2017b). The underlying ability to increase or decrease the degree to which alternative options compete and how strongly goals impact ongoing decision-making is an example of metacontrol.

As Goschke (2000) has pointed out, humans face multiple dilemmas beyond the persistence-flexibility dilemma, such as the exploration-exploitation dilemma or the speed-accuracy dilemma, and more (e.g., Boureau et al., 2015). As long as the factual and neurocognitive basis of these metacontrol dilemmas is not fully understood, this raises the question of whether each one implies a separable metacontrol dimension or system or whether they overlap. For instance, although the description of the exploration-exploitation dilemma overlaps semantically with descriptions of the flexibility-persistence dilemma, the underlying dimensions can be empirically dissociated (van Dooren et al., 2021). Another dilemma that has been described in similar ways as the relationship between persistence and flexibility is the one between local and global processing states. Förster and Dannenberg (2010) suggested that people might process perceived events and internal information either more holistically or with a strong focus on the details. In their GLOMO^{sys} framework, the authors claim that these two processing styles reflect two underlying processing modes—a more global and a more local processing mode. The way these modes are characterized is very similar to characterizations of persistence/stability and flexibility in the accounts of Cools and D'Esposito (2011), Durstewitz and Seamans (2008), Goschke (2000), and Hommel (2015; Hommel & Colzato, 2017b). Moreover, global/local processing modes are assumed to be sensitive to various context conditions, such as bad versus good mood, warm versus cold colors, familiarity versus novelty (Masuda & Nisbett, 2001), personal independence versus interdependence, left-brain versus right-brain activation, and cultural background. Interestingly, some of these conditions have also been discussed in the context of persistence-flexibility dilemmas, such as the impact of positive mood on flexibility in brainstorming tasks (Akbari Chermahini & Hommel, 2012; De Dreu et al., 2008; Dreisbach & Goschke, 2004).

Another important commonality between research on persistence-flexibility and research in the GLOMO^{sys} tradition refers to transfer across different tasks. Information processing routines responsible for transforming stimuli into responses can operate within milliseconds, whereas cognitive control is assumed to operate somewhat more slowly and to be more inert (Allport et al., 1994). Metacontrol would thus be expected to operate at least as slowly and to be at least as inert as the functions it is supposed to control, which is why studies have looked into transfer effects from inducing or priming tasks (Bejjani et al., 2018)—that is, tasks calling for a particular metacontrol bias, such as toward persistence or flexibility—to logically independent probe tasks. For instance, Fischer and Hommel (2012) tested participants on their dual-task performance after just having performed a convergent-thinking or divergent-thinking task. As expected, there was less intertask crosstalk after having performed a convergent-thinking task, suggesting that the persistence-bias that this task is assumed to promote increases task-component switching costs (dual-task costs). Given that the thinking tasks were logically and content-wise unrelated to the dual-task paradigm, this points to a relatively "far" transfer. Along very similar lines, GLOMO^{sys} explicitly postulates that local and global processing modes transfer to other, unrelated tasks (Förster, 2012), and this expectation was met in various studies. In many of them, participants were first confronted with or even trained on a task that was likely to require either a global or a local processing mode, and then tested on an unrelated task to see whether it would be carried out in a different way. The first, priming task often consisted of versions of Navon's (1977) Global/Local task (GLT), in which global stimulus shapes are made of many local stimuli (like a large letter S made of many small Hs), as described in more detail below. Instructing participants to respond to the global stimulus aspect (e.g., the global letter) was assumed to induce a more global processing mode while instructing them to respond to the local aspect should have induced a more local processing mode. Studies have provided evidence that these modes can systematically affect the subsequent (probe) task. For instance, just having responded to global (as compared with local) stimuli has been shown to improve subsequent face identification (Perfect et al., 2008), to increase the number of atypical exemplars in a creativity task (Friedman et al., 2003), to increase estimates of temporal, spatial, and social distance (Liberman & Förster, 2009), or to increase the number of remembered similarities between TV shows (Förster, 2009).

Hence, there is some evidence suggesting that the assumptions of GLOMO^{sys} point to a kind of metacontrol process that is at least very similar to metacontrol in terms of persistence-flexibility, which raises the question of how these two types of processes are related. Unfortunately, however, GLOMO^{sys} is a purely correlational approach that does not provide a mechanistic (functional or neurocognitive) idea suggesting *how* the hypothesized processing modes might operate and how they might generate or be affected by the conditions they are assumed to be correlated with. Hence, while mechanistic models of both persistence-flexibility (Colzato et al., 2016) and exploitation/exploration (Cohen et al., 2007) are available, these cannot be directly compared with the rather metaphorically described GLOMO^{sys}. Given these uncertainties, we decided to take a step back and focus on one particularly important aspect of metacontrol: its relative inertia and the corresponding possibility to find transfer effects across different tasks. As already mentioned, various tasks have provided evidence for this kind of far transfer induced by previous performance on GLTs, which has been taken as strong support for GLOMO^{sys}. However, more recent studies have raised considerable doubt in the replicability of many of these findings (Field et al., 2016; Lawson, 2007; e.g., Fang et al., 2018). One possible interpretation of these failures to replicate is that GLOMO^{sys} may simply be incorrect and global-local processing modes may either not exist or at least not transfer to other tasks. This is indeed the preferred conclusion of the authors of nonreplicating articles. However, another possibility might be that global/local processing modes do exist but they either do not transfer at all or do so only under particular context conditions. For instance, given that practically nothing is known about how volatile metacontrol states are, it is possible that

training participants on a GLT does generate transferable metacontrol states, which however decay so quickly that this will not lead to any significant transfer effect.

These considerations led us to ask whether significant transfer from GLTs can be demonstrated (under highly optimized conditions, Experiments 1A and 1B) at all and, if it could be, whether it would be only near (i.e., affect only very similar tasks) or far as well (Experiments 2A and 2B). Given the strong conceptual relationship between GLOMO^{sys} and Navon's (1977) concept of global versus local processing and the frequent use of Navon's GLT as prime task in studies testing GLOMO^{sys}, we also used the GLT as prime task in all our experiments. We further tried to optimize the experimental conditions for finding transfer by three measures. First, we began searching for transfer between tasks that were almost identical, so to make sure that near-near transfer exists at all. Second, we drastically reduced the temporal distance between prime and probe tasks. Typical tests of GLOMO^{sys} would block the trials of these tasks, by first having participants perform a number of prime trials with an emphasis on either global or local aspects of the stimuli, and then having participants work through a number of probe trials. This raises the possibility that transfer might be absent simply because the possible metacontrol state successfully established in the prime task could safely be abandoned before starting to work on the probe task, so that transfer did not occur for theoretically not particularly interesting reasons. To reduce this possibility, we integrated the two tasks into a kind of dual-task paradigm, in which participants would keep alternating between prime trials that consistently required a global or local focus and probe trials that were expected to be affected by this focus. Third, we drastically reduced dissimilarities between prime and probe tasks even for the tests of relatively far transfer by sticking to probe tasks that were as visual and about as attention-demanding as the prime GLT. These three measures were thought to facilitate transfer, which in turn should make the presence or absence of transfer effects easy to interpret.

Experiments 1A and 1B

Experiment 1 aimed at providing a proof of principle, if possible, for transfer of global/local processing modes (i.e., priming) from one GLT (the prime task) to another task (the probe task)—if it is only logical and temporally separable. We optimized conditions for transfer by minimizing task dissimilarity and the temporal distance between the prime and the probe tasks. In all experiments of this study, we used a setup consisting of two sessions, where in one session the prime task would always favor the global processing mode and in the other session the local processing mode. This was thought to prevent possible fluctuations in the processing mode relevant and used in the prime task, which in turn should render the priming effect particularly strong. Furthermore, we minimized the temporal distance between the prime and probe tasks by alternating between prime and probe trials, which should minimize any possible decay of the global/local processing modes. Hence, our design can be understood as consisting of prime-probe pairs of trials, in which the relevant processing mode of the prime member of each pair was consistent across the given session. In Experiment 1, we also used very similar prime and probe tasks, so to minimize transfer demands. Accordingly, both tasks were variations of the Navon-type GLT (Förster & Dannenberg, 2010), even though they differed with respect to the concrete stimulus set and the concrete instruction on how to respond to the stimuli.

As shown in Figure 1, the prime task presented participants with global squares or rectangles made up of local squares or rectangles. This created congruent trials, in which the local and global shapes were the same, and incongruent trials, in which the local and global shapes differed. In one session, participants were to respond to the global shapes only but to ignore the local shape, and in the other session they responded to local shapes only but ignored the global shape. The mapping of shape to the left or right response key was continuously shown on the screen. The idea was that responding to the global shape would establish a mode that favors the processing of global information and, in particular, globally defined stimuli while responding to the local shape would establish a mode favoring local information processing. If these processing modes would be sufficiently sticky so that they would still be sufficiently activated during the following trial of the probe task, responding to global stimuli in the probe task should be easier in terms of reaction times and error rates if the current prime task would require global processing than if it would require local processing while responding to local stimuli in the probe task should show the opposite effect.

The probe task was also a GLT. As indicated in Figure 1, participants were presented with global letters that were made of local letters. In contrast to the prime task, however, the symbols shown at one level were always neutral in the sense that they were not associated with one of the two response keys. Participants were instructed to respond to the non-neutral letter(s) H and S by pressing the left or right response key. This allowed us to vary the level of processing for the probe randomly from trial to trial without cuing the relevant probe level (as presenting the cue would have increased the time interval between prime and probe task). Participants were thus required first to identify the probe level of the non-neutral letter(s), and we hypothesized that this search would be biased by the prime task or, more specifically, by the level that was relevant in the prime task. More specifically, we expected that, in the probe task, global letters would be responded to faster and more accurately in the global priming session (i.e., with the global level being relevant in the prime task) than in the local priming session, whereas responding to local letters should show better performance than responding to global letters in the local priming session.

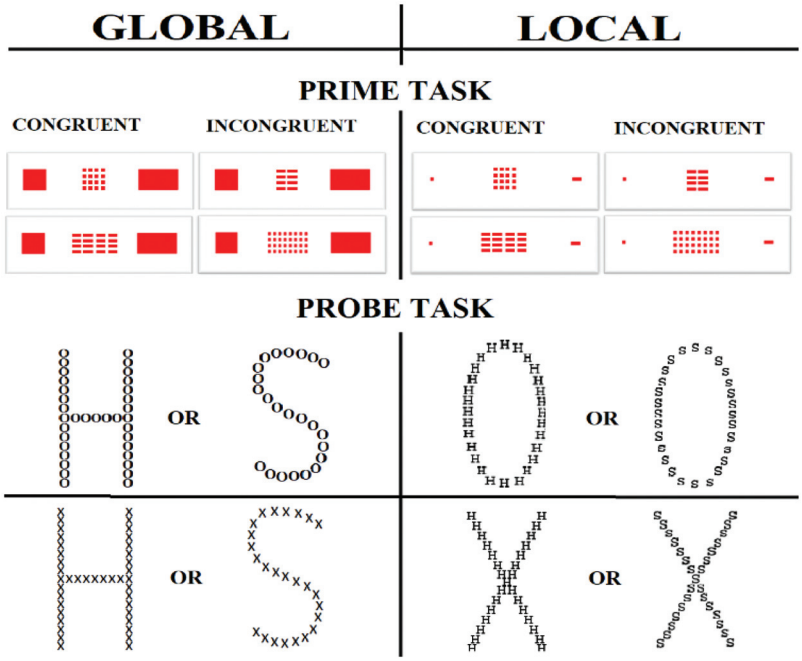
Experiment 1A was conducted in vivo at Leiden University in January and March 2020, just before the coronavirus pandemic. Then, owing to the pandemic, we had to change to online testing and wondered whether online testing would generate results that would be sufficiently comparable with results obtained in vivo. Therefore, we replicated Experiment 1A as an online experiment (1B) by using the same stimuli, tasks, and procedures, with a few minor exceptions.

Method

Transparency and Openness

We report how we determined our sample sizes, all data exclusion, all manipulations, and all measures in the studies, following JARS (Kazak, 2018). All data, analysis code, and research materials are available at https://osf.io/qxahw/. Data were analyzed using SPSS, Version 24.0, and R, Version 2021.09.1 (Build 372), the package BayesFactor, Version .9.12-4.3 and the package GPower,

Figure 1
Prime and Probe Task Stimuli in Experiment 1



Note. See the online article for the color version of this figure.

Version 3.1.9.6. This study's design and its analysis were not preregistered.

Participants

Given our novel design, we were unable to base our sample size on (parameters extracted from or estimates related to) previous research and therefore used our lab standard for studies with unknown effect sizes (at least twice as many as Simmons et al.'s, 2011, recommendation of 20 observations per cell). Accordingly, we accepted all volunteers from the first registration wave with a minimum of 40. Sample-size estimations for Experiments 2 and 3 were based on a priori power analysis based on the effect size of Experiment 1B (see below).

For Experiment 1A, data were collected in vivo at Leiden University during January and March 2020. We analyzed data from 41 students of Leiden University with a mean age of 22.26 years (SD = 3.01; range 18–30; 6 males; 35 females). We excluded data from participants who did not perform the two sessions, who got an accuracy in the prime below 65%, and who answered less than the 65% of probe trials, which amounted to four participants. Our sample consisted of participants in good mental and physical health (this holds for all experiments reported here). They participated for course credits or payment (6.50 euro) and were recruited through the psychology department's standard advertisement system.

For Experiment 1B, data were collected online via the MTurk (https://www.mturk.com) recruiting platform in July 2020. We analyzed the data from 53 participants, with a mean age of 26.78 years (SD = 6.96; range 18–43; 21 males; 24 females; eight did not specify their gender). We excluded data from participants who did not perform the two sessions (24 people), who got an accuracy in the prime below 65% (14 people), and who answered less than the 65% of probe trials, which amounted to 38 participants. They participated in exchange for $4. The advertisement (HIT) on MTurk was restricted to workers with at least a 95% approval rating and 100 or more approved HITs (these restrictions were applied in all following experiments). All participants signed informed consent before the experiment and were naive as to the purposes of the experiments.

All experiments conformed to the Netherlands Code of Conduct for Research Integrity's ethical standards, and the Leiden University Psychology Research Ethics Committee approved the protocol.

Apparatus

Stimulus presentation and data collection were controlled by E-Prime 3.0 software in Experiment 1A and Open Sesame for all other experiments. During the in vivo experiment, stimuli were presented on a Dell desktop computer with a dual-core processor and a 17" CRT monitor. The screen was set up 1,024 × 768, 64Hz in our lab setting and the online version. Open Sesame adapted this for each participant's screen. All presented visual angles are based on a distance of 50 cm from the screen. All online tasks were recorded using a JATOS server (http://www.jatos.org).

Procedure

Both experiments consisted of two sessions (counterbalanced). In one session, participants were to respond to the global stimuli in the prime task (global priming session) and to the local stimuli in the other session (local priming session). This setup allowed us to manipulate global versus local priming as a within-participant variable. The second session was run no earlier than seven days

after the first and was followed by debriefing and compensation. In the first session, participants filled in demographic data, the pleasure and arousal affect grid (Akbari Chermahini & Hommel, 2012), and the tolerance for ambiguity scale (Herman et al., 2010, see Appendix). Because the two variables (pleasure and arousal) are sensitive to the experimental setting, we did not use this questionnaire for the online experiments that followed and due to the option "prefer not to answer," the number of answers was lower than that needed according to the power calculation, so we did not analyze these data (A link to our demographic data can be found at https://osf.io/qxahw/).

Both sessions consisted of four blocks of 48 pairs of prime and probe trials, wherein each prime trial was followed by a probe trial (one block contains 48 prime and 48 probe trials, i.e., 48 trial pairs). Before each session started, 24 practice trials were presented. Participants with an accuracy lower than 75% had to repeat the practice. Each pair of trials consisted of a prime trial, a fixation cross for 300 ms, and the probe trial (see Figure 2). In Experiment 1A, the entire experimental task took about 20 minutes per session.

Prime Task. During this GLT modeled after Huizinga et al. (2006), participants had to pay attention either to the local or global level of a stimulus (depending on the session). Participants were instructed to identify as quickly and accurately as possible whether the stimulus was a square or a rectangle on the level they were paying attention to and press the "v" key or the "m" key accordingly (mapping was counterbalanced). Each trial began with a .95° × .95° fixation cross presented for 300 ms and was followed by the Experimental stimulus (see Figure 2), which stayed on for 1,200 ms. The big square subtended 2.84° × 2.84° and the big rectangle 5.38° × 2.63° of visual angle, the small squares measured .42° × .42° and the small rectangles 1.05° × .38°. All stimuli were red presented on a white background. The response was followed by feedback presented for 300 ms in the form of a colored (red/green) fixation cross, which also encouraged central fixation for the next trial. The trials were 50% congruent (a large square consisting of small squares or a large rectangle consisting of small rectangles) and 50% incongruent (a large square consisting of smaller rectangles or a large rectangle consisting of smaller squares). Both accuracy and reaction times (RTs) were recorded. The prime task was precisely the same for all online experiments (with different background colors according to the probe task used), whereas for the in vivo experiment prime trials were repeated in case the participant made a mistake.

Probe Task. During this GLT, participants were to identify one of the target letters, which could appear either on the local or global level, and to press the corresponding key. In particular, they had to detect Ss and Hs as quickly and accurately as possible and indicate these by pressing "z" and "/" (1A). In the online version (1B), we changed the response to "v" and "m" to accommodate all keyboard layouts. In each trial, the actual target letter was an H or S, while the letter at the other level was the neutral letter O or X. Thus, our stimuli were a global H and S made of local Os and Xs, respectively, and local Ss and Hs making a global × and O. The large letters subtended 3.66° × 7.32° of visual angle, and the small letters .29° × .42° (Times New Roman). All stimuli were black presented on a white background. The specific target (e.g., letters and H to indicate left and right key presses) was varied randomly and presented for 1,200 ms, and followed by a 300-ms fixation cross that turned green (right) or red (error) during the training part.

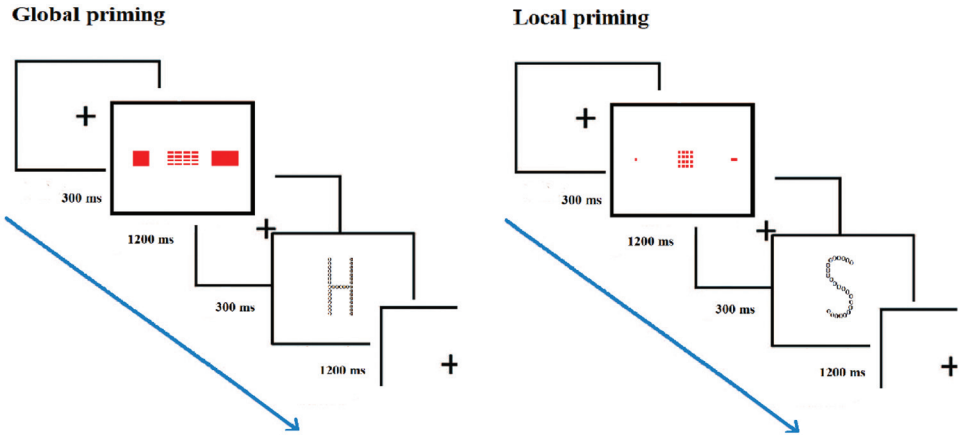
Results

Experiment 1A

We only considered probe trials followed by correct prime trials, prime trials with RTs between 200 and 1,200 ms, and probe trials with RTs and percentages of errors (PEs) within a range of three standard deviations below and above the mean. We kept these exclusion criteria for all the experiments reported here.

Prime Trials. Given that the prime task merely served to draw attention to global or local stimuli, and given that this manipulation was carried out in a blocked fashion (which works against

Figure 2
Experimental Procedure in Experiment 1



Note. The prime task (e.g., global or local priming) was presented before the probe task (GLT) to induce global or local processing modes. In the probe task, participants had to detect one of two letters (e.g., H or S), and each compound stimulus contained only one of the two letters, displayed at the local (small) or global (large) probe level. See the online article for the color version of this figure.

the global-local effect that the GLT is known for), the outcomes of this task are of minor theoretical relevance. Therefore, we only present RTs and PEs for the interested reader but did not analyze these data. In the global priming session, participants responded to congruent and incongruent trials in 520 and 535 ms, respectively, with corresponding error rates of 2.9% and 5.4%. In the local priming session, they responded to congruent and incongruent trials in 526 and 540 ms, respectively, with corresponding error rates of 2.7% and 5.3%.

Probe Trials. The probe data were analyzed using mixed-model repeated measures ANOVAs using priming (priming: global vs. local) and probe level (global probe vs. local probe) as within-participant factors. The ANOVA revealed a significant main effect of probe level on RTs $F(1, 40) = 88.52$, $\eta_p^2 = .69$, $p < .001$, and on PEs, $F(1, 40) = 30.00$, $\eta_p^2 = .43$, $p < .001$, indicating that participants were faster and more accurate when responding to global probe. Probe level interacted with priming in RTs, $F(1, 40) = 17.06$, $\eta_p^2 = .30$, $p < .001$ (see Figure 3). Separate ANOVAs for the two probe levels showed a significant priming effect on local probes, $F(1, 40) = 4.27$, $\eta_p^2 = .10$, $p = .045$, but not on global probes, $p > .5$. Hence, participants were faster in local probe trials when they received local, as compared with global priming. There was no other significant effect in RTs or PEs, $ps > .27$.

Experiment 1B

Prime Trials. In the global priming session, participants responded to congruent and incongruent trials in 572 and 583 ms, respectively, with corresponding error rates of 4.0% and 6.7%. In the local priming session, they responded to congruent and incongruent trials in 568 and 588 ms, respectively, with corresponding error rates of 3.1% and 5.7%.

Probe Trials. The ANOVA yielded a significant main effect of probe level on RTs, $F(1, 52) = 202.87$, $\eta_p^2 = .80$, $p < .001$, and on PEs, $F(1, 52) = 41.30$, $\eta_p^2 = .44$, $p < .001$, indicating that responses were faster and more accurate in global probe. The interaction between priming and probe level effect was significant for RTs, $F(1, 52) = 37.61$, $\eta_p^2 = .42$, $p < .001$. Separate ANOVAs showed a significant priming effect on global probes, $F(1, 52) = 4.39$, $\eta_p^2 = .08$, $p = .041$, whereas the priming effect just missed significance for local probes, $p = .054$. We also found a significant interaction between priming stimulus and probe level on PEs, $F(1, 52) = 6.97$, $\eta_p^2 = .12$, $p = .011$. Separate ANOVAs showed that the priming effect was significant for local probes, $F(1, 52) = 4.48$, $\eta_p^2 = .08$, $p = .039$, but not for global probes, $p = .189$. There was no other significant effect in RTs or PEs, $ps > .33$ (see Figure 4).

Because we could not compute an a priori analysis for this experiment, we also performed a Bayesian repeated measures ANOVA to compare the full model to a model excluding the Priming × Probe Level interaction term. For fixed effects, a prior scale of .5 was used. The model without the interaction effect was 17.7 times more favored than the model including the interaction, corresponding to substantial evidence of an interaction effect (Jeffreys, 1998).

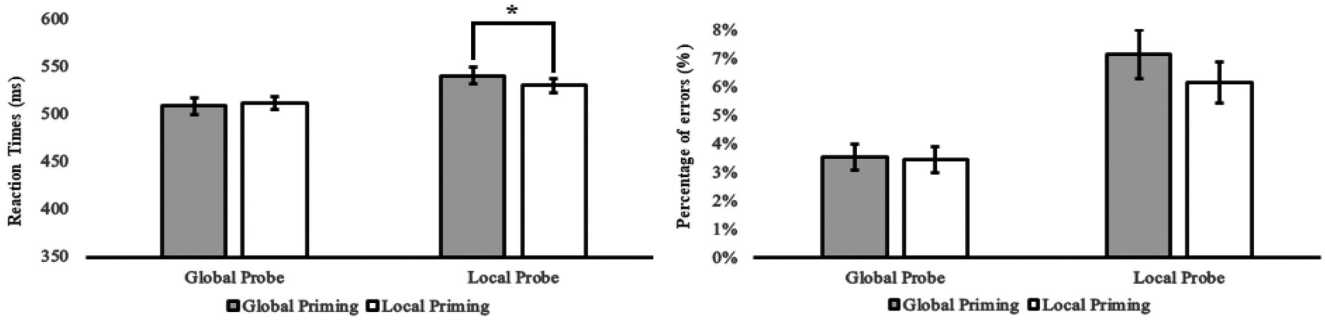
Discussion

Following GLOMO^{sys}, we expected that responding to global probes would be facilitated by just having processed a global stimulus in the prime task, while responding to local probes would be facilitated by just having processed a local stimulus in the prime task. This amounts to an interaction between priming (i.e., the level processed in the prime task and, thus, the level being primed) and the probe level. These predicted interactions were obtained for RTs in Experiment 1A and for both RTs and PEs in Experiment 1B. There were some differences in the statistical outcomes, showing that sometimes the local and sometimes the global probes were affected. However, given that the priming effects resulted from comparing performance in two different sessions with considerable temporal distance, these subtleties might reflect specific effects on general performance (i.e., session effects) that are of no theoretical relevance. Hence, if we consider the significance of the priming-by-probe-level interactions as the most diagnostic outcome, we can take Experiment 1 to confirm the key prediction of GLOMO^{sys}. More theoretically speaking, the two experiments demonstrate that global and local processing modes can transfer to other, logically unrelated tasks. However, given that prime and probe tasks were almost identical, one may argue that the transfer we obtained represents little more than the priming of particular elements of the task set, without necessarily implying an overarching metacontrol state.

Experiments 2A and 2B

Even though Experiment 1 did provide evidence for transfer from the prime to the probe task, at least under the optimized

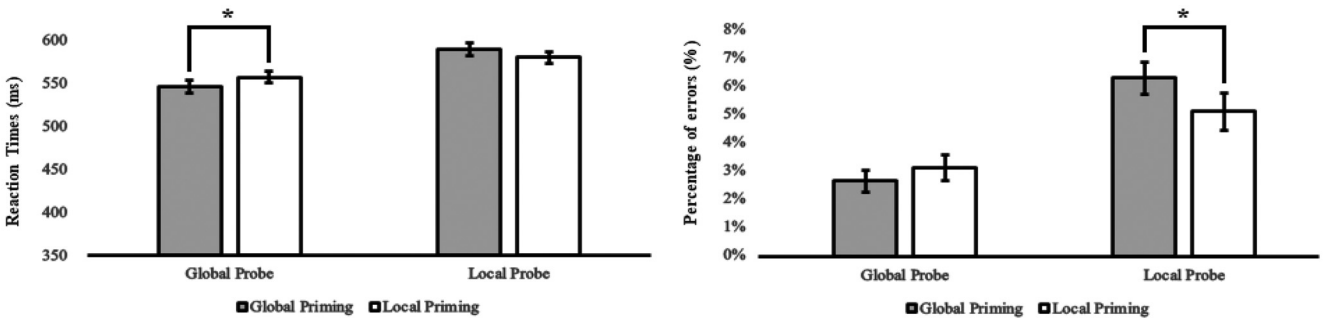
Figure 3
Experiment 1A RTs and PEs in Probe Task, as a Function of Priming and Relevant Level in Probe Task



Note. PEs = percentages of errors. Error bars show standard errors; asterisk indicates a significant priming effect, $p = .045$.

Figure 4

Experiment 1B RTs and PEs in Probe Task, as a Function of Priming and Relevant Level in Probe Task



Note. PEs = percentages of errors. Error bars show standard errors; asterisks indicate a significant priming effect regarding in RTs, $p = .041$, and in PEs, $p = .039$.

temporal conditions we have established, the high degree of similarity between the two tasks renders this near-near transfer, at best. Our next step was thus to test whether transfer could still be obtained if the probe task is less similar to the prime task. As pointed out, we still wanted to have rather optimal transfer conditions by keeping the modality and the attentional demands of the tasks comparable to the prime task. We used a visual flanker task (Eriksen & Eriksen, 1974) in Experiment 2A and the Attentional Blink task (AB; Raymond et al., 1992) in Experiment 2B. Both tasks have been used in experimenting the major control of persistence-flexibility (Hommel & Colzato, 2017a; Iani et al., 2014), suggesting that they are indeed "primable" by metacontrol states. They differ, however, with respect to the "attentional dimension" they tap into: whereas the flanker task taps into spatial attention (i.e., Beanland & Pammer, 2012; the focusing of attention in space), the AB task is tapping into temporal attention (i.e., the focusing of attention in time).

The flanker task requires participants to focus on a central target and to ignore the task-irrelevant and conflict-inducing flankers. The flanker-target congruency effect (i.e., the difference between *congruent* trials, in which the target and the flankers contain the same stimulus, and *incongruent* trials, in which the flankers match the target signaling another response) would be smaller or even absent if participants manage to focus on the target only, which in turn should benefit from a local processing mode. Following GLOMO^{sys}, we thus hypothesized that the flanker-target congruency effect should be smaller if the priming would be local rather than global. This would translate into interaction between priming and flanker-target congruency, with smaller congruency effects after local priming.

The AB task requires participants to report two target stimuli (T1 and T2) that are presented within a stream of (in our and the traditional case visual) other, nontarget stimuli. The term AB refers to the common observation that performance on both targets is reasonably good if T2 appears a second or longer after T1. The shorter the lag of T2 in respect to T1, however, the worse performance becomes. The common interpretation is that processing and storing T1 for later report takes time, and if T2 appears before T1 processing is completed, it is easily missed—a kind of attentional "blink." An interesting aspect of this task is that the AB in some sense reflects a too strong focus on T1, and there is indeed evidence that relaxing this focus and concentration on T1 reduces the size of the AB (e.g., Colzato, Slagter, et al., 2008; see Lippelt et al., 2014). If so, GLOMO^{sys} would suggest that the AB should be smaller after global priming as compared with local priming. This would translate into an interaction between priming and performance in the AB. Hence, this lag effect should be smaller after global priming.

Method

Participants

We used our findings from Experiments 1A and 1B to carry out a power analysis that we used for all the following experiments presented in this article. This a priori power analysis for a repeated-measures analysis of variance examined main effects and interactions with two groups and repeated-measures. Using the software package GPower (Erdfelder et al., 1996) to determine a sufficient sample size using an alpha of .05, a power of .80, and following Cohen's (1988) guidelines for behavioral sciences, assuming an effect size of Cohen's ($d = .43$), the desired sample size turned out to be 34 per experiment. Accordingly, we accepted all registrations from the first wave with a minimum of 34.

For Experiment 2A, data were collected during July and November 2020. We analyzed the data from 54 participants, with a mean age of 28.98 years ($SD = 6.73$; range 18–49; 28 males; 22 females; four did not specify their gender). We excluded data from participants who did not perform the two sessions (21 people), who got an accuracy in the prime below 65% (four people), and who answered less than the 65% of probe trials, which amounted to 25 participants. Forty-two participants were recruited through MTurk, and 12 students from Sona, the online recruiting platform of Leiden University (https://ul.sona-systems.com). Participants received a monetary reward ($4) or two experiment credits.

For Experiment 2B, data were collected on during July and October 2020. We analyzed the data from 49 participants, with a mean age of 24.47 years ($SD = 7.33$; range 18–46; 17 males; 28 females; four did not specify their gender). We excluded data from participants who did not perform the two sessions (14 people), who got an accuracy in the prime below 65% (two people), and who answered less than the 65% of probe trials, which amounted to 16 participants. Twenty-four were recruited through MTurk, and 25 students from Sona. The participants received a payment of

$6 or three credits for participating (because this experiment lasted longer than the previous ones).

Prime Task

This was the same as in Experiment 1A and 1B.

Probe Task (Experiment 2A)

Stimuli were presented in white against a black background. Each stimulus array subtended a visual angle of 6.1° and 1.0° and consisted of seven horizontally arranged arrows that could be congruent or incongruent (see Figure 5). Flanker arrows were presented 100 ms before the target arrow. The entire stimulus array remained on the screen for 1,100 ms. Participants were instructed to respond to the central target by pressing a spatially compatible key on the computer keyboard ("v" or "m") with their left or right index finger, respectively. They were told to respond as quickly as possible while avoiding errors. Including the training of 24 trials, both the local- and global- priming sessions (four blocks, of 48 trials) took 20 mins to complete.

Probe Task (Experiment 2B)

In the AB task, participants were presented with a stream of stimuli and had to respond to the identity of two targets embedded in a stream of distractors. The stimuli were presented in white on a gray background (70,70,70). The lag between the first target (T1) and the second (T2) varied randomly between 1, 3, 5, and 8 distractors (see Figure 6). Participants had to ignore the letters (distractors) and identify and report two numbers (T1 and T2). These streamed letters (distractors) and numbers (targets) were presented in Times New Roman (40 × 40 pixels). With a resolution of 1024 × 768 pixels, items would occupy approximately 1.21 degrees of visual angle.

A fixation cross, which was shown for 300 ms, marked the beginning of each trial. After a blank interval of 250 ms, the rapid serial visual presentation commenced, consisting of 20 items with a duration of 70 ms each and an interstimulus interval of 30 ms. The occurrence of T1 was always in the second position. T2 was presented directly after T1 (lag 1) or in lags 3, 5, and 8, respectively. The training consisted of 24 trials and was automatically repeated if more than 75% of the responses were incorrect. One complete experimental session lasted 30 minutes (four blocks of 40 trials).

Results

Experiment 2A

Prime Trials. In the global priming session, participants responded to congruent and incongruent trials in 574 and 583 ms, respectively, with corresponding error rates of 3.6% and 5.1%. In the local priming session, they responded to congruent and incongruent trials in 574 and 586 ms, respectively, with corresponding error rates of 2.5% and 10.7%.

Probe Trials. RTs and PEs were analyzed by means of mixed-model repeated-measures ANOVAs with the priming (priming: global vs. local) and flanker-target congruency (congruent vs. incongruent) as within-participant factors. The main effect of congruency was significant in both RTs, $F(1, 53) = 514.54$, $\eta_p^2 = .91$, $p < .001$, and PEs, $F(1, 53) = 74.21$, $\eta_p^2 = .58$, $p < .001$, indicating slower responses and more errors on incongruent trials. However, the interaction of priming and flanker-target congruency was not significant for both RTs, $p > .5$, and PEs, $p > .7$. There was no other significant effect in RTs or PEs, $ps > .43$.

Experiment 2B

Prime Trials. In the global priming session, participants responded to congruent and incongruent trials in 623 and 626 ms, respectively, with corresponding error rates of 3.5% and 5.8%. In the local priming session, they responded to congruent and incongruent trials in 631 and 642 ms, respectively, with corresponding error rates of 2.9% and 4.4%.

Probe Trials. We analyzed T2 accuracy scores for trials in which T1 was reported correctly (T2|T1), with priming (priming: global vs. local) and lag (1, 3, 5, 8) as within-participant factors. We obtained a significant lag effect, $F(4, 144) = 9.09$, $\eta_p^2 = .16$, $p < .001$, indicating particularly poor performance at the two shortest lags, that is, when T2 was presented soon after T1—the classical AB effect. However, this lag effect did not interact with priming, $p > .23$. There was no main priming effect, $ps > .73$.

Discussion

Following GLOMO^{sys}, we expected the flanker-target congruency effect in the probe task to be more pronounced after global priming, while the flanker-effect should have been smaller after local priming (Experiment 2A). However, no evidence for the expected interaction between priming and flanker-target congruency was obtained. Similarly, following GLOMO^{sys,} we expected that the AB in Experiment 2B would have been smaller after global priming than after local priming. Again, no evidence for the expected interaction between priming and the lag effect was obtained.

On the one hand, the absence of priming effects in Experiment 2 might be taken to suggest that the transfer of processing modes is possible in principle, as indicated by Experiment 1, but only if the probe task is very similar to the prime task, which was not the case in Experiment 2. On the other hand, however, task similarity might only be an indicator of another, more fundamental issue. Dealing with the cognitive conflict that the flanker task induces is rather demanding, which is why this task is rather robust and often used to assess cognitive control. Conflict can be reduced by properly preparing for the task, by implementing the task set right after having completed the preceding prime trial. Hence, transfer might be possible in principle but only if the agent has no strong reasons to change the processing mode for optimal performance in the probe task. Similarity between tasks might be one indicator that might be taken to signal the need to establish another processing

Figure 5
Congruent and Incongruent Stimuli of the Flanker Task in Experiment 2A

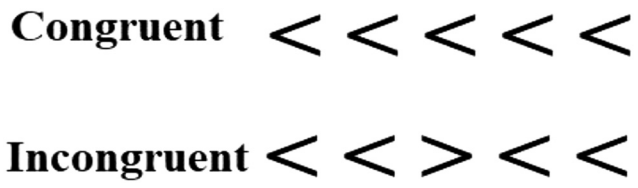
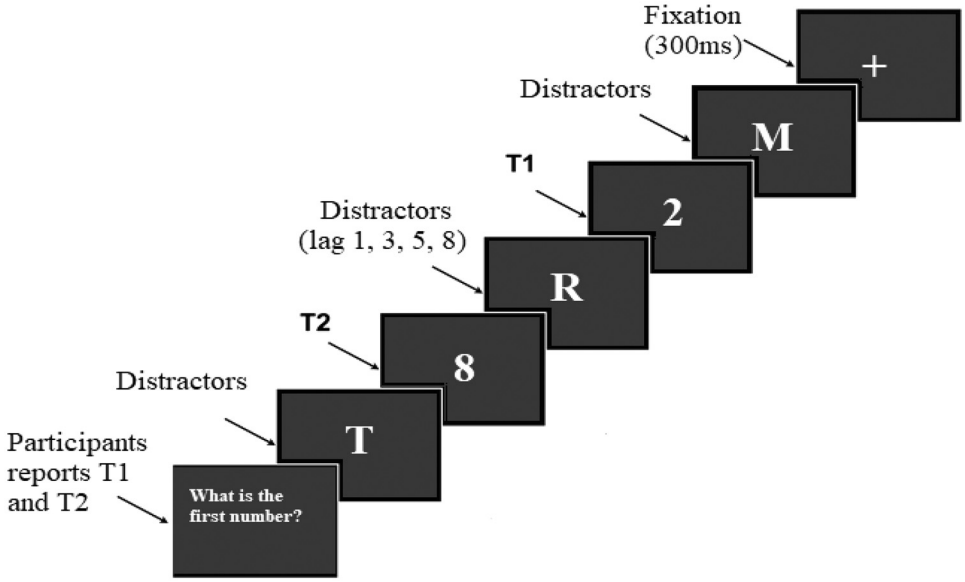


Figure 6
Procedure in the Attentional Blink Task in Experiment 2B



mode, but this could depend on the conflict-inducing characteristics of the particular task version. This might indeed account for the presence of transfer effects in Experiment 1 and the absence of such effects in Experiment 2: in contrast to the two tasks used in Experiment 2, the version of the GLT used in Experiment 1 did not induce any cognitive conflict, and this might have been the actual reason for why transfer was obtained. Hence, the amount of conflict in the probe task might determine the degree of transfer. According to this conflict hypothesis, it should be possible, in principle, to demonstrate transfer between not overly similar tasks if the need to prepare for conflict would be less obvious. Conversely, it should be possible to eliminate transfer between highly similar tasks, as used in Experiment 1, if the need to prepare for conflict would be more obvious.

Experiments 3A and 3B

We tested these two predictions in Experiment 3. In Experiment 3A, we replicated Experiment 1B with a probe task that was very similar to the one used in 1B but that contained incongruent stimuli in 50% of the trials—corresponding to the flanker task in Experiment 2A. This should increase the cognitive conflict in the probe task and render the need to optimally prepare the new task set before processing the probe task more obvious. As a consequence, the priming effect should be reduced or eliminated so that no interaction between priming and level of probe task should be obtained. In Experiment 3B, we replicated the flanker task used in 2A but reduced the proportion of incongruent flankers substantially. This should render the need to optimally prepare the new task set before processing the probe task less obvious, which in turn should generate a significant priming effect (i.e., transfer). Taken altogether, we thus expected that Experiment 3A would not show a priming effect in the probe task (despite its similarity with the probe task of Experiment 1B, where priming was found), whereas Experiment 3B should show a priming effect in the probe task (despite its similarity with the probe task of Experiment 2A, where no priming was found).

Method

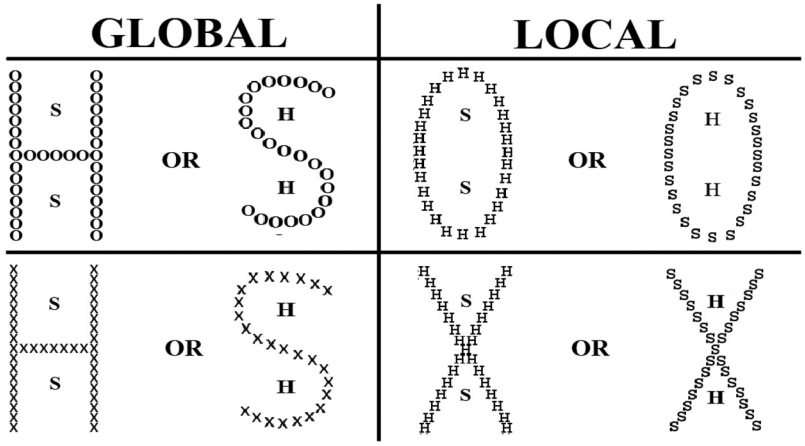
Participants

Experiment 3A was run through the online platform MTurk during December 2020 and January 2021; with a reward of $4. We analyzed data from 41 participants, with a mean age of 30.97 years (*SD* = 6.27; range 20–57; 17 males; 18 females; six did not specify their gender). We excluded data from participants who did not perform the two sessions (109 people), who got an accuracy in the prime below 65% (11 people), and who answered less than the 65% of probe trials, which amounted to 120 exclusions in total.

The Experiment 3B was run through the online platform Prolific (https://prolific.co/) in July 2021; with a reward of £7.50. We analyzed data from 31 participants, with a mean age of 26.22 years (*SD* = 9.41; range 18–59; 15 males; 13 females; three did not specify their gender). We excluded data from participants who did not perform the two sessions (11 people), who got an accuracy in the prime below 65% (11 people), and who answered less than the 65% of probe trials, which amounted to 22 exclusions in total.

The prime task was again copied from Experiment 1B. For the probe task of Experiment 3A, we adopted the basic setup of the probe task in Experiment 1B but increased the conflict by adding distractors to the stimuli: Two small Hs and Ss (distractors) appeared in gray (70, 70, 70), with the target in black (see Figure 7). Each session comprised 24 initial practice trials. Participants with an accuracy lower than 75% have to repeat it. The task takes about 20 minutes. For the probe task of Experiment 3B, we adopted the basic setup of the flanker (probe) task used in Experiment 2A but reduced the conflict by reducing the proportion of incongruent flanker trials

Figure 7
Incongruent Navon GLT Task Stimuli in Experiment 3A



Note. GLT = Global/Local task.

from 50% to 18.75%. After a training block of 24 trials, the Experimental part involved 48 trials, of which nine were incongruent, repeated for four Experimental blocks. The task took 20 minutes to complete.

Results

Experiment 3A

Prime Trials. In the global priming session, participants responded to congruent and incongruent trials in 611 and 628 ms, respectively, with corresponding error rates of 2.9% and 5.6%. In the local priming session, they responded to congruent and incongruent trials in 619 and 638ms, respectively, with corresponding error rates of 3.8% and 6.3%.

Probe Trials. RTs and PEs were analyzed by means of a repeated-measures ANOVA with priming (priming: global vs. local), probe level (global probe vs. local probe), and probe congruency as within-participants factors. The main effect of level was significant in RTs and PEs, $F(1, 41) = 91.05$, $\eta_p^2 = .69$, $p < .001$, and PEs, $F(1, 41) = 36.23$, $\eta_p^2 = .47$, $p < .001$, owing to responses being faster and more accurate on global probes. The congruency effect was obtained on RTs and PEs, $F(1, 41) = 28.28$, $\eta_p^2 = .41$, $p < .001$, and PEs, $F(1, 41) = 8.59$, $\eta_p^2 = .17$, $p = .006$. Both effects interacted with probe level, $F(1, 41) = 5.63$, $\eta_p^2 = .12$, $p = .022$ for RTs, and $F(1, 41) = 5.13$, $\eta_p^2 = .11$, $p = .029$ for PEs, owing to the common observation that responses to local stimuli are more affected by incongruence with a global stimulus than vice versa (Navon, 1977). More importantly, the interaction between priming and probe level was significant for RTs, $F(1, 41) = 13.53$, $\eta_p^2 = .25$, $p < .001$. A paired-samples t test was used to compare the global precedence effect (local probe vs. global probe performance) in global priming and local priming sessions. There was a significant difference in the RTs scores, suggesting that the precedence effect was larger with global priming ($M = 50.27$, $SD = 31.65$) than with local priming ($M = 33.42$, $SD = 33.06$); $t(41) = 3.46$, $p = .001$ (see Figure 8).

Athough the two-way interaction between priming and probe level was not significant PEs, $F < 1$, the three-way interaction approached significance, $F(1, 41) = 4.03$, $\eta_p^2 = .09$, $p = .051$. The underlying numerical pattern showed that the mentioned impact of probe level on the correspondence effect (i.e., smaller correspondence effect on responses to the global, as compared with the local probe; Navon, 1977) was reduced with local priming (where the correspondence effect was 1.76% for global and 2.34% for local responses), as compared with global priming (where the correspondence effect was −.05% for global and 3.11% for local responses). There was no other significant effect in RTs or PEs, $ps > .11$.

Experiment 3B

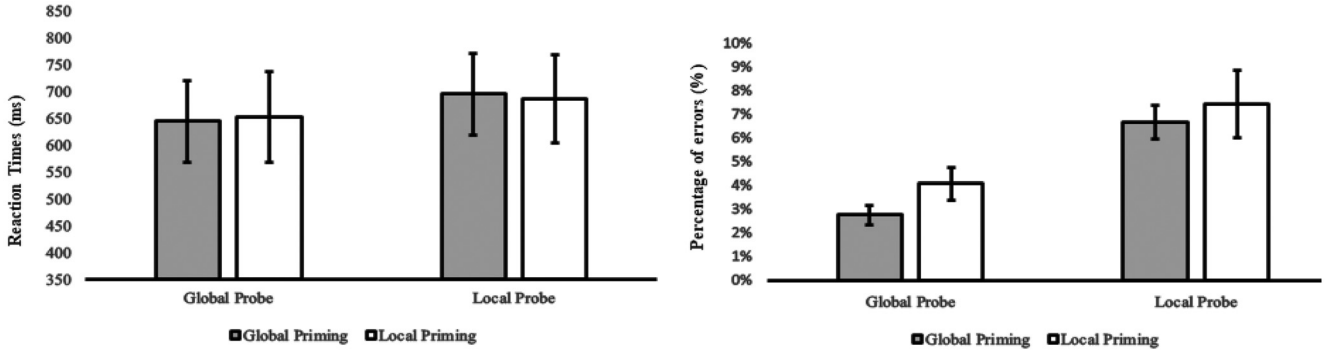
Prime Trials. In the global priming session, participants responded to congruent and incongruent trials in 590 and 597 ms, respectively, with corresponding error rates of 4.2% and 7.5%. In the local priming session, they responded to congruent and incongruent trials in 603 and 610 ms, respectively, with corresponding error rates of 4.5% and 11.7%.

Probe Trials. The data from the flanker task were analyzed by means of mixed-model repeated-measures ANOVAs with the priming (priming: global vs. local) and flanker-target congruency (congruent vs. incongruent) as within-participant factors. The main effect of congruency was significant in both RTs, $F(1, 30) = 194.68$, $\eta_p^2 = .87$, $p < .001$, and PEs, $F(1, 30) = 44.94$, $\eta_p^2 < .60$, $p < .001$, indicating that responses were slower and less accurate in incongruent flanker trials. More importantly, for our purposes, congruency did not interact with priming in RTs, $p > .7$, and so in PEs, $p > .7$. There was no other significant effect in RTs or PEs, $ps > .23$ (see Figure 9).

Because we did not reach the minimum amount of participants according to the a priori analysis, we also performed a Bayesian repeated measures ANOVA to compare the entire model to a model excluding the Priming × Flanker-Target

Figure 8

Experiment 3A RTs and PEs in Probe Task, as a Function of Priming and Relevant Level in Probe Task



Note. PEs = percentages of errors. Error bars show standard errors. A significant priming effect was found on the probe level regarding RTs, $p > .001$.

Congruency interaction term. For fixed effects, a prior scale of .5 was used. The model without the interaction effect was 3.84 times more favored than the model including the interaction, corresponding to substantial evidence against an interaction effect (Jeffreys, 1998).

Discussion

We tested whether increasing the amount of conflict in a probe task that is very similar to the prime task would reduce or eliminate transfer (in Experiment 3A) and whether decreasing the amount of conflict in a probe task that is very different from the prime task would allow for transfer (in Experiment 3B). The outcomes of Experiment 3A and 3B are not consistent with these predictions. Following the conflict hypothesis, we expected that adding conflict in Experiment 3A would have reduced or eliminated the priming effect so that no interaction between priming and probe level would have been obtained. The congruency effect was clearly significant, which shows that our manipulation had worked and that cognitive conflict was successfully induced. Nevertheless, we did obtain a substantial transfer effect, which is contrary to predictions from the conflict hypothesis. The outcome of Experiment 3B is also not consistent with the conflict hypothesis. Following this hypothesis, we expected that reducing the incongruent trials in the flanker task and, thus, the amount of cognitive conflict in this task would have rendered the need to optimally prepare before processing the probe task less obvious, which should have generated a transfer. No such effect was obtained in RTs or PEs.

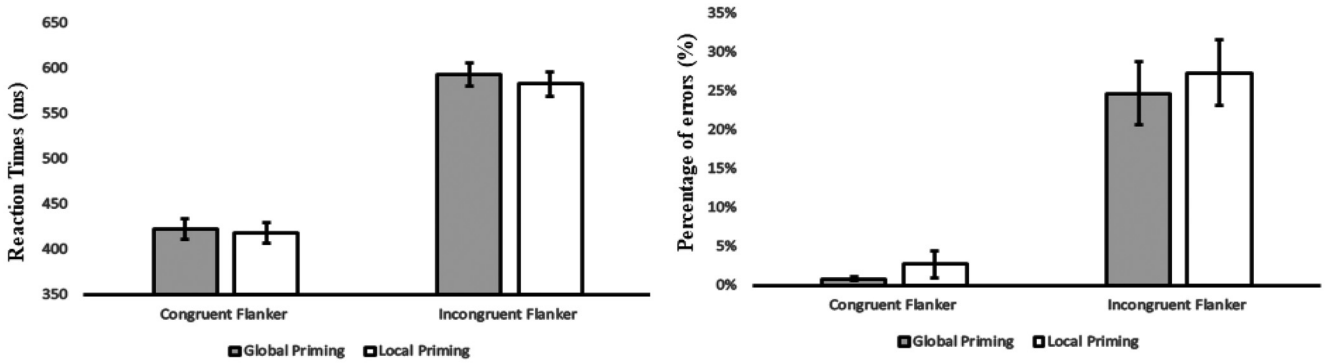
Given that the prime task was blocked with respect to the relevant stimulus, responses in the global priming session could be based on intuitive response tendencies: Navon's (1977) global precedence effect indicates that global responses do not suffer a lot from incongruency with local stimuli, which is also consistent with the interactions between probe level and probe congruency we obtained in Experiment 3A. Hence, participants were able to trust their automatic response tendencies more in the global than in the local priming sessions. Drastically reducing the incongruent trials in the flanker task did not create a transfer effect, so we conclude that Experiment 3 failed to provide convincing, unequivocal evidence for the conflict hypothesis of transfer.

General Disussion

The aim of the present study was to test whether global-local processing modes can transfer to logically unrelated tasks, as

Figure 9

Experiment 3B RTs and PEs in Probe Task, as a Function of Priming and the Congruency in Probe Task



Note. PEs = percentages of errors. Error bars show standard errors; no significant effect of priming was found on the congruency of the Flanker Task regarding RTs, $p > .7$, and PEs, $p > .7$.

claimed by GLOMO^{sys}. We used Navon's GLT as the prime task in all six experiments and have blocked the relevant stimulus level (global vs. local). According to GLOMO^{sys}, this should have established a global processing mode in the global-prime sessions and a local processing mode in the local-prime sessions. In contrast to many previous transfer tests, which have used probe tasks with very different characteristics than the prime task and thus probing far transfer, all our probe tasks used the same sensory modality and were about as attention-demanding as the GLT used for priming. Furthermore, our probe trials were temporally as close as possible to the prime trials. This rules out many theoretically unimportant reasons why previous studies might have failed to demonstrate transfer effects predicted by GLOMO^{sys}. In other words, the conditions in our tasks were designed to be as favorable as possible for transfer to occur. Indeed, we found convincing supporting evidence for transfer in Experiments 1A, 1B, and 3B, where performing a task that calls for global processing enhanced subsequent performance on a task that also required global processing as compared with local processing, and vice versa. Hence, we were able to demonstrate convincing evidence for near-near transfer from a GLT task.

To test for the possibility of somewhat farer transfer, we used slightly more dissimilar tasks in Experiments 2A, 3A, and 3B. Although the probe tasks relied on the same sensory modality and were about as attention-demanding as the GLT used for priming, none of these experiments showed any evidence for the transfer effects that GLOMO^{sys} predicts. Furthermore, Experiment 3 ruled out the alternative conflict hypothesis as an explanation of why we did not find transfer effects in Experiment 2. It should be noted that previous studies, including ones that demonstrated significant transfer effects, have used a somewhat different priming logic. Rather than interweaving the priming of the probe task, as in our present experiments, previous studies commonly used a separate priming block consisting of a substantial number of trials of the priming task, followed by a block of probe trials (e.g., Gao et al., 2011; Huntsinger et al., 2010; Schmid et al., 2011). On the one hand, primes and probes were temporally much more separated on average in these block designs than in our present study, suggesting that, if anything, our present design should have been more sensitive to pick up transfer effects. On the other hand, however, the number of prime trials that participants experienced before the first probe trial was more pronounced, which might be speculated to promote transfer. We do not consider this argument very strong, because it is hard to see why this difference might have rendered previous priming studies more successful and because our present Experiments 1A, 1B, and 3B have successfully demonstrated that our design is sufficiently sensitive to pick up transfer effects. Nevertheless, it might be worthwhile to systematically assess possible differences between block-based priming and trial-to-trial priming in future studies.

Taken altogether, this must be considered as a failure to confirm the claim of GLOMO^{sys} regarding the transfer of global-local processing modes across tasks and domains, even under very optimal, transfer-friendly conditions. One possible conclusion from these findings would be that focusing on the global or local aspects of stimuli requires relatively task- or process-specific control parameters that might prime corresponding control parameters in very similar tasks but that are not sufficiently general to affect the processing style in sufficiently different tasks (i.e., tasks that require other control parameters). If so, the regulation of global/local processing does not need to be considered as an act of metacontrol or requires the implementation of metacontrol-like states with the potential to affect the processing style of the entire cognitive system. However, it might also be that metacontrol states are so task-specific that they tend to be switched off as soon they are no longer needed and/or replaced by states that are optimal for the next upcoming trial. Indeed, several authors have suggested, and provided empirical evidence, that cognitive representations of trials and tasks might include codes specifying the task context and relevant control parameters, which are then automatically retrieved whenever the same task is encountered (Dignath et al., 2019; Jiang et al., 2014; Schumacher & Hazeltine, 2016; Spapé & Hommel, 2010; Waszak et al., 2003). If this also holds for metacontrol states, it is possible that transfer effects can only be demonstrated under very particular, not yet sufficiently well understood circumstances, which apparently were not present in the experiments of our study. If so, this would not necessarily undermine the key assumptions of GLOMO^{sys} and would not necessarily disqualify global-local processing modes as metacontrol states, but would render transfer tests as generally unsuitable methods to demonstrate and assess the existence of such states.

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Appendix

Instrument

Tolerance of Ambiguity 12-Item Scale (Herman et al., 2010)

Items included in final measure:

1. I avoid settings where people don't share my values. [Reverse Coded]
2. I can enjoy being with people whose values are very different from mine.
3. I would like to live in a foreign country for a while.
4. I like to surround myself with things that are familiar to me. [Reverse Coded]
5. The sooner we all acquire similar values and ideals the better. [Reverse Coded]
6. I can be comfortable with nearly all kinds of people.
7. If given a choice, I will usually visit a foreign country rather than vacation at home.
8. A good teacher is one who makes you wonder about your way of looking at things.
9. A good job is one where what is to be done and how it is to be done are always clear. [Reverse Coded]
10. A person who leads an even, regular life in which few surprises or unexpected happenings arise really has a lot to be grateful for. [Reverse Coded]
11. What we are used to is always preferable to what is unfamiliar. [Reverse Coded]
12. I like parties where I know most of the people more than ones where all or most of the people are complete strangers. [Reverse Coded][1]

Screening and Demographic Questionnaire

The first session of each experiment (1A, 1B, 2A, 2B, 3A, 3B) started with a screening questionnaire wherein we asked participants to report any variables that might influence their performance on our tasks. Owing to the sensitivity of the questions, each answer section had the option of "Prefer not to say." We asked for this information to describe our sample in terms of factors that have been found to affect metacontrol policies. The demographic variables were: age, sex, profession, education, and mental and physical health. We excluded subjects who abused alcohol and recreational drugs (cigarettes included). We also required participants not to have been diagnosed with a psychological disease. Lastly, colorblind participants were excluded because the task required color discrimination. Furthermore, we inquired about religion (Colzato, van den Wildenberg, et al., 2008), meditation habits (Hommel & Colzato, 2017a), and sexual orientation (Colzato, van den Wildenberg, et al., 2008) because these are known to influence meta control style (for an overview see, Hommel & Colzato, 2017b). A link to our demographic data can be found at https://osf.io/qxahw/.

The Tolerance for Ambiguity Scale

People differ in the tolerance for ambiguity, and this difference between individuals explains their Cognitive control styles (Budner, 1962). Thus, after the screening questionnaire, we asked participants to fill in the Tolerance for Ambiguity Scale (TA; Herman et al., 2010).

[1] All items are scored on a 5-point Likert scale, ranging from 1 = *Strongly Disagree* to 5 = *Strongly Agree* and a 3 = *Neither Agree nor Disagree* option in the middle. (This scoring pattern is inverted for items followed by [Reverse Coded], above). From "The tolerance for ambiguity scale: Towards a more refined measure for international management research," by J. L. Herman, M. J. Stevens, A. Bird, M. Mendenhall, and G. Oddou, 2010, *Journal of Intercultural Relations*, *34*(1), pp. 58–65 (https://doi.org/10.1016/j.ijintrel.2009.09.004). Copyright 2010 by Elsevier. Reprinted with permission.

(*Appendix continue*)

Pleasure and Arousal Affect Grid

Akbari Chermahini and Hommel (2012) reported that performing a task requiring persistence or flexibility is sufficient to induce corresponding mood changes. To investigate whether our global/local priming influences participants' pleasure and arousal, we administered a 9 × 9 Pleasure × Arousal affect grid (Russell et al., 1989) before the prime-probe procedure immediately after the experiment to assess pleasure and arousal. The questionnaire data can be found at https://osf.io/qxahw/.

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