BRIEF REPORTS

Contextual control over task-set retrieval

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Contextual cues signaling task likelihood or the likelihood of task repetition are known to modulate the size of switch costs. We follow up on the finding by Leboe, Wong, Crump, and Stobbe (2008) that location cues predictive of the proportion of switch or repeat trials modulate switch costs. Their design employed one cue per task, whereas our experiment employed two cues per task, which allowed separate assessment of modulations to the cue-repetition benefit, a measure of lower level cue-encoding processes, and to the task-alternation cost, a measure of higher level processes representing task-set information. We demonstrate that location information predictive of switch proportion modulates performance at the level of task-set representations. Furthermore, we demonstrate that contextual control occurs even when subjects are unaware of the associations between context and switch likelihood. We discuss the notion that contextual information provides rapid, unconscious control over the extent to which prior task-set representations are retrieved in the service of guiding online performance.

Memory for routine action often facilitates performance but can derail performance in novel circumstances. Consider the routine drive from home to work. Prior experience will guide you to work successfully, but when you intend to drive to the grocery store on the weekend you sometimes find yourself on your way to work. The context of getting into your car acts as a powerful cue triggering the actions necessary to drive yourself to work, even when you plan otherwise. These real-world situations emphasize a distinction between centralized, voluntary planning processes and more decentralized, involuntary memory processes participating in the control of performance (Brooks, 1987; Logan, 1988; Rickard, 1997). We are specifically interested in understanding how contextual information cues the retrieval of prior experiences to guide current performance. Recent research on task switching has demonstrated different forms of contextual control over task performance (Leboe, Wong, Crump, & Stobbe, 2008; Mayr & Bryck, 2005, 2007; Rubin & Koch, 2006). The results of the present experiment clarify claims by Leboe et al. that context may have the ability not only to trigger the retrieval of previous task sets (e.g., whether your car signals the drive to work) but also to provide general control over the extent to which memory processes contribute to performance (e.g., whether the retrieved actions are actually applied to performance).

Switching between different tasks is well known to slow performance and increase errors (Jersild, 1927; for reviews, see Kiesel et al., 2010; Monsell, 2003). Our interest in the present work is to understand the role of context-sensitive processes that modulate the cost of switching tasks. The no-

tion that contextual information modulates aspects of task performance is a broad theme that touches on several existing issues in the task-switching literature. One issue is the popular distinction between endogenous and exogenous influences in task switching, which has been the focus of much debate. *Endogenous influences* refers generally to demonstrations that advance preparation—allowing for task-set reconfiguration to occur in advance of an upcoming task—can reduce switch costs (Goschke, 2000; Meiran, 1996; Rogers & Monsell, 1995). *Exogenous influences* refers generally to demonstrations that stimulus processing can modulate switch costs by activating associated responses (Allport & Wylie, 2000; Rogers & Monsell, 1995) or task sets (Koch & Allport, 2006; Mayr & Bryck, 2005, 2007; Rubin & Koch, 2006; Waszak, Hommel, & Allport, 2003, 2004, 2005). *Exogenous influences* can also refer to demonstrations that probabilities associated with task structure can modulate switch costs (Dreisbach & Haider, 2006; Dreisbach, Haider, & Kluwe, 2002; Gotler, Meiran, & Tzelgov, 2003; Koch, 2005; Schneider & Logan, 2006a, 2006b). Our focus on context-sensitive processes fits underneath the umbrella of exogenous influences over switch costs and relates to both stimulus processing and probability-learning aspects of exogenous influences, which we describe in turn.

Numerous researchers have demonstrated a role for stimulus processing in influencing switch costs. For example, switch costs are generally larger for bivalent target stimuli that invoke responses for the relevant and irrelevant task (Allport & Wylie, 2000; Rogers & Monsell, 1995). Furthermore, learning of stimulus–response associations and stimulus–task associations can modulate switch costs

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(Koch & Allport, 2006; Waszak et al., 2003, 2004, 2005). Additionally, processing of nominally irrelevant contextual information that is associated with particular tasks can influence the size of switch costs (Mayr & Bryck, 2005, 2007; Rubin & Koch, 2006). Taken together, these findings suggest that stimulus processing of task-relevant or task-irrelevant information can trigger the retrieval of task-set representations controlling performance. Our present work extends these findings by demonstrating that contextual cues may also control whether or not associated task-set representations are retrieved in the service of guiding performance.

Switch costs occur for both predictable and unpredictable tasks (Rogers & Monsell, 1995). Advance knowledge of sequential task structure modulates performance in task-switching experiments (Schneider & Logan, 2006a). However, incidental learning of task sequences can speed performance but does not influence switch costs (Koch, 2005). Several studies demonstrated that manipulating the likelihood of switch trials can modulate switch costs (Dreisbach & Haider, 2006; Dreisbach et al., 2002; Leboe et al., 2008; Schneider & Logan, 2006b). For example, switch costs are generally smaller for blocks of trials with high switch-proportions than for blocks of trials with low switch-proportions. One interpretation of these findings is that participants explicitly learn blockwide switch likelihoods and then develop blockwide strategies governing whether they abandon or maintain task sets across trials (Dreisbach & Haider, 2006; Monsell & Mizon, 2006). Although this interpretation accounts for some results, recent studies have identified alternative processes that could account for the influence of switch likelihood on switch costs (e.g., priming of cue encoding or sensitivity to transition frequency; Schneider & Logan, 2006b). Our present work extends these findings and demonstrates a unique role for contextual information in signaling information about switch likelihoods and modulating switch costs.

Our investigation brought together both stimulus-driven and probability-driven aspects of exogenous influences over switch costs. We were specifically interested in clarifying a recent finding by Leboe et al. (2008), who demonstrated that task-irrelevant location information associated with switch likelihood modulates switch costs. Switches occurred on 25% of the trials in one location and on 75% of the trials in another location; switch costs were smaller in the location with more frequent switches. The Leboe et al. study differed from other studies of contextual influences over switch costs, which associated contextual information with particular tasks instead of with switch likelihood (Mayr & Bryck, 2005, 2007; Rubin & Koch, 2006). The Leboe et al. study also differed from other studies of switch likelihoods, which manipulated switch likelihood between blocks instead of within blocks (but see Rubin & Koch, 2006).

Our aim was to better understand how contextual cues modulated switch costs in the Leboe et al. (2008) design. The present study addressed two accounts. First, participants may have explicitly learned associations between location context and switch likelihood. In this view, contextual modulation of switch costs occurred because participants employed different strategies in the high and low

switch-proportion locations. For this account to hold, participants would have required awareness of the location-specific switch-proportion manipulation. Leboe et al. did not assess awareness, whereas the present study did assess awareness.

Second, Leboe et al. (2008) employed a one-cue-per-task design, wherein task repetitions always involved task-cue repetitions, and task switches always involved task-cue alternations. As a result, their measure of switch costs confounded the cost associated with alternating tasks with the benefit associated with encoding repeated task cues (Logan & Bundesen, 2003; Mayr & Kliegl, 2003). Moreover, the location-specific switch-proportion manipulation necessarily biased the frequency of task-repetition trials between locations. There were more task-repetition trials in the low switch-proportion location than in the high switch-proportion location. As a result, the switch cost in the low switch-proportion location was composed of many observations from task-repetition trials, in which a cue-repetition benefit would be observed, and of few observations from task-alternation trials, in which a cost would be observed. Similarly, the switch cost in the high switch-proportion location was composed of few observations from task repetitions, in which a less reliable cue-repetition benefit might be observed, and of many observations from task-alternation trials, in which a reliable cost would be observed. In this way, Leboe et al.'s finding may not reflect contextual control over processes involved in switching tasks but may more simply reflect the fact that cue-repetition benefits were more likely to occur in the low switch-proportion contexts than in the high switch-proportion contexts. Fortunately, this confound can be addressed by using two cues per task, which provides separate measures of cue-repetition benefits and task-alternation costs (Logan & Bundesen, 2003; Mayr & Kliegl, 2003). The primary purpose of the present experiment was to replicate the experiments of Leboe et al. using a two-cue-per-task design to determine whether contextual information modulates cue-encoding processes, task-set switching processes, or both.

We made several modifications to the Leboe et al. (2008) design.[1] Leboe et al. used animal habitat and relative size judgments of target words. Our task involved magnitude or parity judgments of target digits. Leboe et al. employed a prime–probe design, where trial $n-1$ (the prime task) was presented centrally to the right of fixation, and trial n (the probe task) was presented in the top left (e.g., the low switch-proportion location) or in the bottom left (e.g., the high switch-proportion location) of the same display. Our design eliminated the prime–probe aspect and instead presented cue–target pairs randomly in one of two locations: above or below fixation. Each location context was associated with a low (.25) or high (.75) proportion of switch trials but did not predict particular tasks, stimuli, or responses. Leboe et al. did not interrogate their subjects to determine awareness of the context-specific switch-proportion manipulation, whereas our subjects completed a questionnaire probing their explicit knowledge of the manipulation.

The most important modification was to employ a two-cue-per-task design, which involved three between-trial transitions: *cue repetitions* (trials $n-1$ and n involved the

same cue and task), *task repetitions* (trials $n-1$ and n involved different cues but the same task), and *task alternations* (trials $n-1$ and n involved different cues and tasks). These three transition types decomposed switch costs into separate measures for cue encoding and task-set switching processes. For example, cue repetitions are generally faster than task repetitions, reflecting a benefit to encoding repeated task cues (i.e., a cue-repetition benefit). Task repetitions are generally faster than task alternations, reflecting a cost associated with switching task sets (i.e., a task alternation cost). By employing a two-cue-per-task design, we were able to assess whether the context-specific switch-proportion manipulation modulated the size of the cue-repetition benefit, the task-alternation cost, or both. If the Leboe et al. (2008) finding was driven entirely by different patterns of cue-repetition benefits in the different location contexts, we would not expect the context-specific switch-proportion manipulation to modulate the task-alternation cost. Instead, we would expect larger cue-repetition benefits in the low switch-proportion location than in the high switch-proportion location.

METHOD

Subjects

Subjects were 32 students from Vanderbilt University. All subjects were compensated with course credit or were paid $12 for 1 h of participation. All subjects had normal or corrected-to-normal vision.

Apparatus and Stimuli

The experiment was conducted on a PC using a 15-in. SVGA monitor running in-house software controlled by METACARD.

There were four target stimuli, consisting of the numbers 2, 4, 7, and 9. There were two possible tasks, and each task was signaled by one of two task cues. Two cues per task were chosen from a set of four arbitrary symbols (#####, $$$$$, ^^^^^, ~~~~~). The symbols were randomly assigned to each task for each subject. The response key mapping at the bottom of the screen displayed the meaning of each cue throughout the experiment. All stimuli were 60 mm in height and were presented in Helvetica font.

Design

The two-cue-per-task design involved three between-trial transitions: cue repetitions (trials $n-1$ and n involved the same cue and

task), task repetitions (trials $n-1$ and n involved different cues but the same task), and task alternations (trials $n-1$ and n involved different cues and tasks). All possible cue–target pairs were presented with equal frequency. Cues and targets were always presented simultaneously, with the cue 2 cm above the target.

On each trial the cue–target pair appeared randomly in one of two locations, either 6 cm above or 6 cm below the central fixation point. The context-specific switch-proportion manipulation was applied to the location contexts. For half of the subjects, cue–target pairs appearing in the top location were 25% task-switch trials, and cue–target pairs appearing in the bottom location were 75% task-switch trials. For the other half, the assignment of proportion to location was reversed. Cue repetitions and task repetitions were equally likely. Importantly, location information uniquely predicted likelihood of task switches and was not predictive of particular responses, stimuli, task cues, or tasks.

Procedure

There were 64 trials per block for 11 blocks. Each block presented 32 trials in each location context. At the beginning of each trial, a fixation cross (0.3 cm) was presented in the center of the screen for 500 msec. Next, the cue–target pair appeared in either the top or the bottom location and remained on the screen until a response was given. The cue and target were always presented simultaneously. Subjects indicated their response by pressing a left ("z") or right ("/") key. The response mapping was displayed throughout the experiment in the bottom left and right corners of the display. For example, the words *odd* and *small* were displayed on the bottom left, and *even* and *large* were displayed on the bottom right. Response mappings were counterbalanced across subjects. We included only incongruent trials and ensured that the response mappings required different responses for the different tasks. The next trial was automatically triggered immediately following the response. At the end of each experiment, subjects completed a questionnaire probing their explicit knowledge of the context-specific repetition-proportion manipulation.

RESULTS

For each subject, response times (RTs) for each condition were submitted to an outlier elimination procedure (Van Selst & Jolicœur, 1994), which removed 3% of the data from each condition. Mean RTs were computed from the remaining observations, and, along with error rates, are reported in Tables 1 and 2. RTs and error rates were submitted to separate 2×2 repeated measures ANOVAs including switch proportion (low vs. high) and transition

Table 1
Mean Reaction Times (in Milliseconds) and Error Rates

	Cue Repetition			Task Repetition			Task Alternation		
	Reaction Time		Error	Reaction Time		Error	Reaction Time		Error
	M	SE	Rate	M	SE	Rate	M	SE	Rate
25% switch proportion	1,010	41.19	.06	1,243	61.22	.06	1,358	58.67	.09
75% switch proportion	1,038	49.22	.05	1,276	58.25	.06	1,346	62.86	.09

Table 2
Cue-Repetition Benefits and
Task-Alternation Costs (in Milliseconds)

	Cue-Repetition Benefit		Task-Alternation Cost	
	M	SE	M	SE
25% switch proportion	233	32.79	115	28.15
75% switch proportion	238	32.02	70	31.66
Context-specific switch-proportion effect	−4	31.46	45	22.56

Table 3
Repeated Measures ANOVAs for Reaction Times and Error Rates

| | Reaction Times | | | | | | Error Rates | | | | | |
| | CR Trials vs. TR Trials | | | TR Trials vs. TA Trials | | | CR Trials vs. TR Trials | | | TR Trials vs. TA Trials | | |
Factor	$F(1,31)$	MS_e	p	$F(1,31)$	MS_e	p	$F(1,31)$	MS_e	p	$F(1,31)$	MS_e	p
Switch proportion	8.860	3,288.48	.0056	0.84	3,110.63	.36	0.04	.00099	.53	0.020	.0005	.88
Transition	96.110	18,468.70	.0001	15.39	17,705.80	.0005	3.78	.00400	.06	10.920	.0014	.002
Switch proportion × transition	0.023	5,689.93	.88	5.46	2,920.51	.026	0.44	.00096	.51	0.015	.0010	.90

Note—CR, cue repetition; TR, task repetition; TA, task alternation.

(cue repetition vs. task repetition in one ANOVA, and task repetition vs. task alternation in the other) as factors. Statistical analyses are reported in Table 3. We adopted a $p < .05$ criterion for all statistical tests.

As expected, RTs were faster for cue-repetition trials (1,024 msec) than for task-repetition trials (1,260 msec) $[F(1,31) = 96.11, MS_e = 18,468.7]$, which were in turn faster than those for task-alternation trials (1,352 msec) $[F(1,31) = 15.39, MS_e = 17,705.8]$. The more important issue was whether the context-specific switch-proportion manipulation influenced cue-repetition benefits, task-alternation costs, or both.

For task-alternation costs, the switch proportion × transition interaction was significant $[F(1,31) = 45.46, MS_e = 2,920.51]$. Task-alternation costs were larger in the low switch-proportion context (115 msec) than in the high switch-proportion context (70 msec), resulting in a context-specific switch-proportion effect of 45 msec. For cue-repetition benefits, the proportion × transition interaction was not significant. Critically, this pattern of findings lends new insight into the contextual-control effect reported by Leboe et al. (2008): Contextual cues associated with switch likelihood modulated the task-alternation costs, a measure of higher level processes involved in task-set switching, and did not modulate cue-repetition benefits, a measure of lower level processes involved in cue encoding.

Additionally, there was a main effect of proportion for cue-repetition and task-repetition trials $[F(1,31) = 8.86, MS_e = 3,288.48]$. Collapsing across cue-repetition and task-repetition trials, RTs were faster in the low switch-proportion trials [1,128 msec] than in the high switch-proportion trials [1,157 msec]. Error rates were submitted to a corresponding set of analyses. The only significant effect was that error rates were higher for task alternations (.09) than for task repetitions (.06) $[F(1,31) = 10.92, MS_e = .0014]$.

DISCUSSION

We investigated context-driven modulations to cue-repetition benefits and to task-alternation costs. The location-based contextual cues were associated with different proportions of task-switch trials but were not associated with particular tasks, task cues, stimuli, or responses. There were two central findings. First, contextual cues modulated the size of the task-alternation cost, which was larger in the low switch-proportion context than in the high switch-proportion context. Second, contextual

cues produced a main effect for cue-repetition and task-repetition trials, where RTs for both trial types were faster in the low switch-proportion context than in the high switch-proportion context. These results clarify the kinds of processes that underlie the contextual control effects reported by Leboe et al. (2008).

Previous research into context-sensitive processes in task switching has demonstrated two distinct findings. First, contextual cues associated with specific tasks modulate the size of switch costs (Mayr & Bryck, 2005, 2007; Rubin & Koch, 2006). These tasks all employed a one-cue-per-task design, and it is not clear whether the reported modulations influenced cue-repetition benefits, task-alternation costs, or both. Second, contextual cues associated with different proportions of switch trials modulate the size of switch costs (Leboe et al., 2008). The present research suggests that this second type of contextual control uniquely influences the task-alternation cost. In prior work, in which contextual cues were associated with tasks, contextual cues may have caused retrieval of associated task sets. In the present work—and in the Leboe et al. study—contextual cues were associated with the likelihood of a task switch, which is more abstract than associations with tasks. The associations mediating contextual control may or may not require a role for associations between contextual cues and switch likelihood.

Transition Frequency and Cue-Encoding Time

Performance in explicit task-cuing procedures involves cue encoding and target encoding (Logan & Bundesen, 2003). Cue-encoding time is influenced by several factors (Logan & Schneider, 2006), including repetition priming and associative priming (Schneider & Logan, 2005) and the frequency with which cue transitions occur (Schneider & Logan, 2006b). These factors may explain the contextual control effects Leboe et al. (2008) observed. In their experiment, cue repetitions were more frequent in the low switch-proportion condition than in the high switch-proportion condition, so cue encoding would be more likely to be primed in the low switch-proportion condition. Our experiment ruled out this account, demonstrating that the contextual modulation affected task-alternation costs but not cue-repetition benefits.

Our experiment also biased the frequency of particular transitions presented in each location. Cue and task repetitions were more frequent in the low switch-proportion location than in the high switch-proportion location, whereas task alternations were more frequent in the high switch-proportion location than in the low switch-

proportion location. If subjects were sensitive to location-specific differences in transition frequency, RTs would be faster for frequent transitions than for infrequent transitions. This would explain the contextual modulation of task-alternation costs and the main effect of switch proportion observed for cue-repetition and task-repetition trials. First, task alternations were more frequent than task repetitions in the high switch-proportion location than in the low switch-proportion location. Consequently, RTs should have been faster for task alternations and slower for task repetitions in the high switch-proportion location than in the low switch-proportion location (Schneider & Logan, 2006b), as we observed. Second, RTs for both cue and task repetitions were faster in the low switch-proportion location than in the high switch-proportion location. Cue and task repetitions occurred with higher frequency in the low switch-proportion location than in the high switch-proportion location, so both cue-repetition RTs and task-repetition RTs would be faster; however, cue and task repetitions occurred with equal frequency within each location, so no difference in cue-repetition benefits would be expected.

Location-specific learning of transition frequencies provides a compelling explanation of the present findings. We do note, however, that the present experiments biased task-alternation frequency against cue- and task-repetition frequency only directly and did not separately manipulate cue- and task-repetition frequencies between contexts. Consequently, we must remain cautious in accounting for the present findings solely in terms of transition frequency, because not all transition frequencies were manipulated.

Incidental Learning of Task Sequences

Our context-specific manipulation of switch likelihood is similar to manipulations of sequential structure in implicit sequence learning experiments. In both types of experiments, an underlying probability structure constrains the frequency of particular transitions. In sequential-learning studies, target-identification RTs become faster over the course of practice, even when subjects are unaware of the learned sequential structure (for a review, see Clegg, DiGirolamo, & Keele, 1998). Similarly, in implicit learning of task sequences in task-switching procedures, subjects perform faster for learned sequences (Gotler et al., 2003), but the learning speeds performance across all transition types (Koch, 2005). Although it is possible that implicit sequence learning contributed to our present findings, it is unlikely that it produced switch-specific modulations to performance.

Conscious Awareness

The cost of switching tasks is known to be influenced by advance knowledge. Switch costs are smaller when subjects have time to prepare for an upcoming task (Meiran, 1996; Rogers & Monsell, 1995), are given advance knowledge of the sequence of upcoming tasks (Schneider & Logan, 2006a), or are given series of trials with a high likelihood of task alternation (Dreisbach & Haider, 2006; Dreisbach et al., 2002; Monsell & Mizon, 2006; Schnei-

der & Logan, 2006b). Our findings, as well as Leboe et al.'s (2008), cannot be explained by advance knowledge of specific tasks or of the requirement to switch tasks. The location context that predicted the proportion of switch trials did not appear before the cue and target and so could not be used to predict the likelihood of a task switch on an upcoming trial.

It is possible, however, that subjects became aware of the context-specific switch-proportion manipulation and strategically adjusted their performance in response to location information presented at the onset of a given trial. Indeed, Dreisbach and Haider (2006) found reduction in switch costs when subjects were explicitly cued about the likelihood of receiving a task repetition or alternation. Leboe et al. (2008) did not measure subjects' awareness of the context-specific switch-proportion manipulation. We had our subjects answer a questionnaire at the end of the experiment, in which they estimated the proportion of task repeats and task alternations separately for each location context. Average estimates were .50 and .50 for repeats and alternations, respectively, in the low switch-proportion location, and .48 and .53 for repeats and alternations, respectively, in the high switch-proportion location. In both cases, repeated measures ANOVAs including switch proportion (high vs. low) and trial type (repeat vs. switch) found no significant differences between estimates (all $Fs < 1$). These findings suggest that subjects were not aware of the context-specific switch-proportion manipulation. The notion that contextual control processes operate outside of awareness fits well with other demonstrations of contextual control in the Stroop (Crump, Gong, & Milliken, 2006; Crump, Vaquero, & Milliken, 2008) and visual search (Chun, 2000) paradigms.

Sensitivity to Conditional Probabilities of Task Alternations

Manipulating task-alternation probability in a two-cue-per-task design involves both the unconditional probability that a task alternation will occur and the conditional probability that a task switch will occur given a cue switch. In principle, subjects can become sensitive to the conditional probability of a task switch given a cue switch, and they may use cue alternations as a signal to abandon task-set representations for an upcoming trial (Mayr, 2006; Monsell & Mizon, 2006). When cue alternations are associated with a high probability of task alternation, subjects may perform a fast same–different judgment upon receiving the cue and, given a cue alternation, rapidly abandon their current task set for the upcoming target. This would speed performance on task-alternation trials but would slow performance on task-repetition trials, since subjects would have abandoned their prior, matching task set; however, Logan, Schneider, and Bundesen (2007) showed that same–different judgments of successive cues took much longer than did identifying the current cue, so same–different judgments may not be fast enough to support this strategy. Moreover, the strategy actually predicts slower RTs on task-repetition trials (which require two switches, one away from and one back to the original task) than on task-alternation trials (which require only one switch),

and this difference has never been observed (see Logan et al., 2007).

Alternatively, subjects may be sensitive to the conditional probability of task alternations given a location cue, which was the primary manipulation in our design. In this case, subjects may have learned to abandon task sets when the cue and the target appeared in the high switch-proportion location, and to maintain task sets when the cue and the target appeared in the low switch-proportion location. For the high switch-proportion context, location information would speed performance on task-alternation trials and slow performance for task-repetition and cue-repetition trials. For the low switch-proportion context, location information would slow performance on task-alternation trials but speed performance on task-repetition and cue-repetition trials. This fits well with the finding that contextual cues produced larger task-alternation costs in the low switch-proportion context than in the high switch-proportion context and produced overall faster RTs for cue and task repetitions in the low switch-proportion context than in the high switch-proportion context.

Contextual Control Over Task-Set Retrieval

When context influences performance, we assume that processing is influenced by memory. The role of memory retrieval has been a topic of substantial debate in the task-switching literature; however, there is common agreement that memory retrieval influences processing of cues (Logan & Bundesen, 2003), responses (Allport & Wylie, 2000; Rogers & Monsell, 1995), and task sets (Waszak et al., 2003, 2004, 2005). Our present findings suggest an additional role for memory in providing control over whether or not memory retrieval occurs.

We assume that memory operates according to the principle of transfer-appropriate processing (Morris, Bransford, & Franks, 1977). In performance, transfer-appropriate processing predicts that the influence of memory is determined by the match between current and prior processing demands (Hommel, 1998, 2004; Milliken, Joordens, Merikle, & Seiffert, 1998). In task-switching procedures, memory for recent experience facilitates performance when task demands repeat and interferes with performance when task demands switch. We suggest that in addition to the match between current and prior processing, the recruitment of memory is also controlled by match probability. Contextual cues associated with different task-switch likelihoods may automatically retrieve control settings that determine the extent to which memory influences current performance. For example, in a high switch-proportion location, reliance on memory is usually inappropriate, because retrieval of the previous task set will interfere with current task demands. In this case, contextual information would become associated with a control setting that discourages memory retrieval of a prior task set. This would reduce task-alternation costs, slowing performance on cue- and task-repetition trials. In a low switch-proportion location, retrieval of the previous task set will usually facilitate performance. In this case, contextual information would become associated with a control setting that encourages memory retrieval of a prior

task set. This would facilitate cue and task repetitions and produce larger task-alternation costs.

The notion that contextual cues associated with switch likelihood control the extent to which memory retrieval guides performance provides another complete account of the present findings. This proposal connects our research with more general investigations into the obligatory nature of memory retrieval. For example, Logan (1988) distinguished between algorithmic processes involved in computing solutions to a given problem and automatic memory processes involved in retrieving solutions. Logan assumed that the transition from algorithmic processes to memory retrieval was automatic, but Rickard (1997) showed that under some circumstances, people can strategically determine whether to engage an algorithm or to rely on retrieval. Our present data suggest that reliance on memory retrieval can be adjusted in a context-specific manner.

Conclusions

Leboe et al. (2008) demonstrated that contextual cues associated with different proportions of task-switch transitions can modulate the size of the switch cost. The central question addressed by the present experiment was whether these contextual modulations of switch costs operate at the level of task-set switching or at the level of cue encoding. We distinguished between these alternatives using a two-cue-per-task design. The critical finding was that contextual cues modulated the size of task-alternation costs but not the size of cue-encoding benefits. Our findings can be explained by a learning process sensitive to location-specific biases to transition frequencies or by a learning process sensitive to location-specific associations, with task-switch likelihood controlling the extent to which memory retrieval influences performance. The present data do not allow us to distinguish between these alternatives. Regardless, both accounts establish a novel role for contextual control over performance in the task-switching domain. Our approach is not intended to de-emphasize the role of higher level voluntary processes controlling performance, but to further understand the role of more decentralized contextual processes that allow memory to lead the way (Brooks, 1987).

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NOTE

1. An initial attempt to reproduce the results of Leboe et al. (2008) failed to detect any influences of the location-specific switch-proportion manipulation on the cue-repetition benefit or on the task-alternation cost. This prior experiment was identical to the present one, except that meaningful words were employed as task cues; task cues were the following: odd/even, parity, large/small, and magnitude. In the present experiment, as well as in Leboe et al., arbitrary symbols were employed as task cues (e.g., #####, %%%%%, ^^^^^, ~~~~~). The fact that the context-specific switch-proportion manipulation depended on the format of the task cue was not theoretically relevant to the present article; nevertheless, the discrepancy is worth highlighting as a cautionary note for future research. Specifically, it appears that measurement of contextual control over performance in task-switching procedures can depend on specific task parameters.