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Do Mental Processes Share a Domain-General Resource?

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Abstract

What determines success and failure in dual-task situations? Many theories propose that the extent to which two activities can be performed concurrently depends on the nature of the information involved in the activities. In particular, verbal and visuospatial activities are thought to be fueled by distinct resources, so that interference occurs between two verbal activities or two visuospatial activities, but little or no interference occurs between verbal and visuospatial activities. The current study examined trade-offs in four dual-task situations in which participants maintained verbal or visuospatial information while concurrently processing either verbal or visuospatial information. We manipulated the cognitive load of concurrent processing and assessed recall performance in each condition. Results revealed that both verbal and visuospatial recall performance decreased as a direct function of increasing cognitive load, regardless of the nature of the information concurrently processed. The observed trade-offs suggest strongly that verbal and visuospatial activities compete for a common domain-general pool of resources.

Keywords

working memory, domain generality, attention, resource sharing

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Successes and failures of human beings performing two or more tasks simultaneously have long intrigued psychologists. The nature of the limited resources underlying dual-task performance has become a fundamental issue in psychological science because of its importance in understanding the limits of human information processing and its practical implications for multitasking in real-world work situations, such as air-traffic control (e.g., Wickens, 1992), and in daily life situations, such as using a cell phone while driving (e.g., Kieras & Meyer, 1997; Strayer & Johnston, 2001). The nature of limited resources and the potential interference between mental activities when performed concurrently remains a controversial issue affecting cognitive, developmental, social, clinical, and educational psychologists.

One widely held view is that human information processing activities are supported by multiple resources. For example, Navon and Gopher (1979) proposed that the human information processing system incorporates a number of mechanisms, each drawing on its own pool of resources. This idea was further elaborated by Wickens (1984), who proposed a three-dimensional taxonomy of resources based on stages, processing codes, and modalities. The second dimension in Wickens's model (i.e., processing codes) included separate pools of resources for verbal and spatial information processing.

Similar domain-specific assumptions about the nature of limited resources were included in multiple-resource models of working memory (e.g., Baddeley & Logie, 1999). *Working memory* refers to a limited-capacity system responsible for the simultaneous storage and processing of information (Baddeley, 1986; Baddeley & Hitch, 1974). Several theorists proposed that working memory consists of multiple domain-specific subsystems, with each subsystem being fueled by its own pool of resources (e.g., Baddeley & Logie, 1999). In particular, they made a distinction between resources supporting verbal activities and those supporting visuospatial activities. According to such multiple-resource accounts of working memory, and of human information processing in general, the nature of limited resources is domain-specific. Therefore, interference between two concurrent tasks would occur when the tasks involve information pertaining to the same domain (i.e., when they both involve verbal information or when they both involve spatial information), but no (or very little) interference would occur when the tasks involve information pertaining to different domains.

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This predicted pattern of interference has been demonstrated over the past 40 years in working memory research. As stated by Saito and Towse (2007), the concept of working memory offers "a productive and fertile environment in which psychological issues can be investigated" (p. 73). This is especially true for the nature of limited resources because of the inherent dual functioning of working memory. Typically, dual-task demands are imposed by requiring the maintenance of some information (i.e., storage task) while additional information is being processed (i.e., processing task). Using this method, researchers have shown that dual-task performance depends on the particular combination of information involved in the two tasks. Visuospatial recall performance is poorer when paired with visuospatial processing activities (e.g., spatial tapping or mental rotation) than when paired with verbal processing activities (e.g., articulatory suppression resulting from continuously reciting the word "the" or verifying sentences). Conversely, verbal recall performance is poorer when paired with verbal processing activities than when paired with visuospatial processing activities (e.g., Bayliss, Jarrold, Gunn, & Baddeley, 2003; Farmer, Berman, & Fletcher, 1986; Logie, Zucco, & Baddeley, 1990; Meiser & Klauer, 1999; Shah & Miyake, 1996). These observations are consistent with the widely accepted idea of mental processes being supported by domain-specific limited resources.

However, alternative assumptions about the nature of limited resources have been put forward in models that propose a general-purpose pool of limited resources that supports various cognitive activities (e.g., Barrouillet, Bernardin, & Camos, 2004; Case, 1985; Kahneman, 1973). This pool of resources is often called *attention* and is thought to be shared between mental processes regardless of the nature of the information involved. In this view, verbal and visuospatial activities are assumed to compete for a common pool of domain-general limited resources, resulting in interference between such activities when they are performed concurrently. Although the aforementioned patterns of interference clearly indicate some domain specificity, they are not at odds with the existence of domain-general limited resources at a more central level of the information processing system. For example, one could imagine that both verbal and visuospatial processing activities disrupt verbal maintenance activities because all three tap into a common central pool of resources, but that verbal processing activities disrupt verbal maintenance more than visuospatial processing activities do because they also share a more peripheral domain-specific resource.

Even though selective domain-specific interference is often, explicitly or implicitly, interpreted as contradicting the idea of domain-general limited resources, direct empirical evidence against the existence of domain-general resources is scarce. Furthermore, studies involving various complex span tasks (i.e., tasks requiring concurrent processing and storage) found that latent variables for recall on verbal complex span tasks and latent variables for recall on visuospatial complex span tasks were identical or shared 65% or more of their variance (e.g., Kane et al., 2004; Kyllonen, 1993; Oberauer, Süß, Wilhelm, & Wittmann, 2003; but see Shah & Miyake, 1996). These correlational results suggest the presence of a domain-general resource underlying both verbal and visuospatial mental processes. However, the existence of domain-general limited resources remains to be established experimentally by demonstrating interference between verbal and visuospatial activities.

Consistent with the existence of a domain-general resource is the finding that verbal recall performance was significantly lower when a verbal storage task was combined with demanding visuospatial processing activities than when performed alone (Baddeley, Logie, Bressi, Della Sala, & Spinnler, 1986). Such a dual-task decrement was not observed by Cocchini, Logie, Della Sala, MacPherson, and Baddeley (2002), but the finding by Baddeley et al. demonstrates that different-domain activities sometimes interfere with each other. However, as noted by Navon and Gopher (1979), one should be cautious in interpreting performance decrements from single-task to dual-task situations as evidence for resource sharing because of the possibility of a *concurrence cost*. Such a cost could, for example, arise from the need to coordinate the concurrent operation of two systems (see also Baddeley, 1986; Duff & Logie, 2001). More recently, Maehara and Saito (2007) avoided the possibility of differing concurrence costs by examining interference between verbal and visuospatial activities in dual-task situations in which processing and storage requirements were manipulated. They obtained partial evidence of domain-general limited resources, but failed to demonstrate domain-general effects of processing requirements (i.e., cognitive load) on recall performance.

The goal of the present study was to demonstrate experimentally the existence of domain-general resources supporting verbal and visuospatial activities. We believe that the most straightforward, and perhaps the only, way to do so is to examine trade-offs between same-domain and different-domain activities in dual-task situations. This approach not only avoids concurrence-cost interpretations, but also enjoys a long history in psychological research. The lack of trade-offs between two tasks is interpreted as evidence against a common underlying resource (e.g., Baddeley & Hitch, 1974; Caplan & Waters, 1999; Towse & Hitch, 1995). In contrast, if two tasks draw on a common pool of resources, one task is accomplished at the expense of the other, so increasing the demands of one task draws resources away from, and should impair performance on, the other task when it is performed concurrently.

Within the framework of the time-based resource-sharing (TBRS) model of working memory (Barrouillet et al., 2004; Barrouillet, Bernardin, Portrat, Vergauwe, & Camos, 2007), we have developed a new dual-task paradigm in which processing and storage activities are combined under strict time control, thereby allowing rigorous manipulations of processing demands (i.e., cognitive load). In the TBRS model, cognitive load is defined as the proportion of time during which processing activities capture attention in such a way that memory traces cannot be attentionally refreshed. Using computer-paced complex span tasks, we previously demonstrated that recall performance is a direct function of the cognitive load of concurrent processing, thereby establishing that processing and storage share a common resource in a time-based way (i.e., sharing in which time plays a crucial role) when both activities involve verbal information (e.g., Barrouillet et al., 2004, 2007) or both activities involve visuospatial information (Vergauwe, Barrouillet, & Camos, 2009).

For the present study, four computer-paced complex span tasks were created by combining verbal and visuospatial storage with both verbal and visuospatial processing. We manipulated the cognitive load of concurrent processing and examined its effect on recall performance. If a domain-general resource is shared between verbal and visuospatial activities, then recall performance should be affected by changes in cognitive load that are induced by the processing component of both same-domain and different-domain task combinations. Conversely, if verbal and visuospatial activities rely on separate resources, trade-offs should be observed only when processing and storage involve same-domain information. We predicted that, in line with the TBRS model, recall performance would decrease as a direct, monotonic function of the increased cognitive load of concurrent processing activities, regardless of the nature of the information stored and processed.

Method

Participants and design

Ninety-six undergraduate psychology students (87 females and 9 males; mean age = 22.84 years) enrolled at the University of Geneva participated for course credit and were randomly assigned to one of the four between-subjects conditions defined by crossing storage domain (verbal vs. visuospatial) and processing domain (verbal vs. visuospatial). Cognitive load (low, medium, or high) was manipulated within subjects.

Tasks and materials

Four complex span tasks were created by crossing a verbal storage (letter span) task and a visuospatial storage (location span) task with a verbal processing (semantic categorization) task and a visuospatial processing (visuospatial fit judgment) task. All tasks were computerized. For the verbal storage task, series of consonants of ascending length (3–6 consonants) were used, and participants had to correctly recall as many letters in these series as possible. All consonants, excluding *W*, were used approximately equally often. No consonant was repeated within a series. Acronyms and alphabetically ordered series were avoided.

For the visuospatial storage task, series of 4 × 4 matrices were used, ascending in length from 2 to 5 matrices. Each matrix contained one red square that appeared at a different location for each matrix in a series, and each of the 16 locations was used approximately equally often. Participants had to correctly recall the location of the red square in as many matrices in these series as possible.

The processing tasks were both two-choice reaction time tasks. A set of 24 five-letter words was used for the verbal processing task; half of them were animal nouns (see Oberauer et al., 2003, for a similar verbal task). The animal and nonanimal words were matched for word frequency in French. Throughout the experiment, the 24 words were used approximately equally often, and no word was repeated within a processing phase. The words were presented one at a time, and the total number of words presented in a processing phase varied according to the cognitive-load condition. Participants were instructed to judge whether the presented word was an animal noun or not.

Stimuli used in the visuospatial processing task were the same as those used in the visuospatial fit task in Experiment 1 of our previous study (Vergauwe et al., 2009). They consisted of a set of 24 white boxes, each of which contained a black horizontal line and two square black dots. The horizontal line was centrally displayed, and the dots were positioned on the same horizontal plane as each other, either above or below the horizontal line. The line varied in length, and the distance between the dots was chosen in such a way that, for half of the boxes, the line could fit into the gap between the dots. The boxes were presented one at a time, and participants were instructed to decide whether or not the line could fit into the gap. The number of boxes presented in a processing phase varied according to the cognitive-load condition. No box was repeated within a series, and the 24 boxes were used approximately equally often.

Procedure

Each trial comprised a series of storage items, with each storage item followed by a processing phase. Each trial began with an asterisk centrally displayed for 750 ms, followed by a 500-ms delay and then a series of storage items interleaved with processing phases. Each storage item was presented for 1,000 ms (for a total of 2,000–6,000 ms spent viewing the storage items, depending on the number of items in the series), followed by another 500-ms delay and then a processing phase.

We manipulated the duration of the processing phases and the number of items to be processed sequentially for three cognitive-load conditions. In the low-cognitive-load condition, four items were presented in 8,000 ms, and each item was displayed for 1,333 ms followed by a 667-ms delay. In the medium-cognitive-load condition, four items were presented in 5,172 ms, and each item was displayed for 862 ms followed by a 431-ms delay. In the high-cognitive-load condition, eight items were presented in 8,000 ms, and each item was displayed for 667 ms followed by a 333-ms delay. Participants were asked to rest their left and right index fingers on a left and a right keyboard key and to press one of these as quickly and as accurately as possible to indicate their choice for each processing item (left for "does fit" and "animal noun," right for "does not fit" and "nonanimal noun"). Responses and reaction times were recorded. At the end of each trial, the word "rappel" (i.e., "recall") appeared, and participants recalled the items in the storage series in order of appearance by reproducing the letters (from the letter-span task) or locations of the red squares (from the location-span task) on response sheets.

The experiment started with a training phase in which participants were trained on the processing task before performing 6 practice trials of the complex span task (i.e., 2 trials for each cognitive-load condition). All participants were then required to perform 36 trials, presented in four consecutive blocks of 9 trials. Each block corresponded to one of the four lengths of series of storage items, and the four blocks were presented in order of ascending series length. Within each block, three series of storage items were associated with each cognitive-load condition. For each nine-series block, the association of the various series with the cognitive-load conditions was counterbalanced across participants, as was the order of presentation of the series. Recall performance was scored by calculating a span score (i.e., the number of items participants were able to maintain) for each cognitive-load condition across the four blocks. Each correctly recalled series counted as 1/3 point, and participants could earn up to 4 points within each cognitive-load condition (1/3 point for each of four series lengths in each of three repetitions for a given cognitive load). Because the series started with minimum lengths of either two or three storage items, either 1 or 2 points were added to the sum of thirds for visuospatial and verbal recall performance, respectively, to make the maximum possible score correspond with the maximum series lengths.

Results

Mean accuracy was 91% and 90% on the verbal and visuospatial processing tasks, respectively. Performance on both tasks was lower when combined with visuospatial storage than when combined with verbal storage and declined with increases in cognitive load. Details of these analyses are available in the Supplemental Material available on-line. Two participants with accuracy below 80% were dropped from the sample.

Visuospatial and verbal recall performance were both analyzed by running a 3 (cognitive load: low, medium, or high) × 2 (processing domain: verbal or visuospatial) analysis of variance with cognitive load as a repeated measure and processing domain as a between-subjects factor. A temporal analysis was conducted by plotting, for each participant, observed recall performance (i.e., span under low, medium, and high cognitive load) against the approximated proportion of time during which processing captured attention. This proportion was calculated using the following formula: $CL = \Sigma P/T$, with CL referring to cognitive load, ΣP referring to mean total processing time (i.e., mean sum of response times within the processing phases), and T referring to total time allowed (i.e., duration of each processing phase; see Barrouillet et al., 2007).

Visuospatial recall performance

When paired with the visuospatial storage task, mean processing accuracy was 89% for both the verbal and the visuospatial processing tasks. Cognitive load had a significant effect on visuospatial recall performance, $F(2, 88) = 23.40$, $p_{rep} > .99$, $\eta_p^2 = .35$. Increasing the cognitive load of concurrent visuospatial processing impaired visuospatial recall performance, $F(2, 43) = 12.91$, $p_{rep} = .99$, and in line with our predictions, the same was true for increasing the cognitive load of concurrent verbal processing activities, $F(2, 43) = 7.28$, $p_{rep} = .99$. There was no effect of processing domain, $F(1, 44) = 1.00$, $p_{rep} = .76$, $\eta_p^2 = .02$, nor was there an interaction, $F(2, 88) = 1.60$, $p_{rep} = .81$, $\eta_p^2 = .04$ (Table 1). Interestingly, both manipulations of increasing cognitive load resulted in poorer recall performance: Decreasing the duration of the time in which a fixed number of items had to be processed (i.e., low vs. medium cognitive load), $F(1, 44) = 12.73$, $p_{rep} = .99$, $\eta_p^2 = .22$, and increasing the number of items to be processed within a processing phase of fixed duration (i.e., low vs. high cognitive load), $F(1, 44) = 38.22$, $p_{rep} > .99$, $\eta_p^2 = .46$, both impaired visuospatial recall performance.

Verbal recall performance

When paired with the verbal storage task, mean processing accuracies were 94% and 92% for the verbal and visuospatial processing tasks, respectively. Cognitive load had a significant

Table 1. Recall Performance in the Four Task Combinations as a Function of Cognitive Load

	Visuospatial storage				Verbal storage			
	Verbal processing		Visuospatial processing		Verbal processing		Visuospatial processing	
Cognitive load	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Low	2.99	1.00	2.98	0.89	5.36	0.58	5.56	0.55
Medium	2.82	0.82	2.44	0.65	4.97	0.66	5.33	0.67
High	2.38	0.82	2.12	0.74	4.72	0.60	5.17	0.77
Mean	2.73		2.52		5.02		5.35	

effect on verbal recall performance, $F(2, 92) = 23.54$, $p_{rep} > .99$, $\eta_p^2 = .34$. Increasing the cognitive load of concurrent verbal processing activities had a detrimental effect on verbal recall performance, $F(2, 45) = 21.71$, $p_{rep} > .99$, but, as we predicted, this was also the case when concurrent processing involved visuospatial information, $F(2, 45) = 8.18$, $p_{rep} = .99$. There was a main effect of processing domain, $F(1, 46) = 4.10$, $p_{rep} = .92$, $\eta_p^2 = .08$, but cognitive load and processing domain did not interact, $F(2, 92) = 1.43$, $p_{rep} = .79$, $\eta_p^2 = .03$ (Table 1). As was the case for visuospatial storage, increased cognitive load resulted in poorer verbal recall performance both when cognitive load was increased by decreasing the time available for processing (low vs. medium cognitive load), $F(1, 46) = 12.31$, $p_{rep} = .99$, $\eta_p^2 = .21$, and when cognitive load was increased by increasing the number of items to be processed (low vs. high cognitive load), $F(1, 46) = 55.14$, $p_{rep} > .99$, $\eta_p^2 = .55$.

Temporal analyses

As illustrated in the upper panel of Figure 1, a smooth monotonic relationship was observed between visuospatial recall performance and cognitive load. Analysis of individual data revealed that the average slope value for recall performance when paired with visuospatial processing (–3.80) was significantly different from zero, $t(21) = 3.98$, $p_{rep} = .99$, as was the average slope for recall performance when paired with verbal processing (–2.77), $t(23) = 4.22$, $p_{rep} = .99$. The intercepts of these regression lines did not differ from each other, $t(44) = 0.59$, $p_{rep} = .66$, and there was no significant difference between the slopes, $t(44) = 0.84$, $p_{rep} = .72$. These results demonstrate that visuospatial recall performance decreases as the cognitive load of concurrent processing increases and that this trade-off is not affected by the nature of the concurrently processed information.

Analysis of individual verbal recall performance data revealed that the average slope value when paired with verbal processing (–3.00) was significant differently from zero, $t(23) = 6.54$, $p_{rep} = .99$, as was the average slope when paired with visuospatial processing (–1.66), $t(23) = 3.96$, $p_{rep} = .99$. The intercepts of these regression lines did not differ from each other, $t(46) = 0.60$, $p_{rep} = .66$, however, the slopes were significantly different, $t(46) = 2.18$, $p_{rep} = .93$, which suggests that the trade-off between verbal recall performance and cognitive load is affected by the nature of the concurrently processed information. Indeed, verbal recall performance decreased as the cognitive load of concurrent processing (whether verbal or visuospatial) increased, but this decrement was larger when concurrent processing activities were also verbal. The lower panel of Figure 1 shows two distinct linear regression lines, one representing the smooth monotonic relationship between verbal recall performance and the cognitive load of verbal processing and another demonstrating the smooth monotonic relationship between verbal recall performance and the cognitive load of visuospatial processing.

Discussion

Our findings clearly show that verbal and visuospatial activities can interfere with each other in dual-task situations. They suggest strongly that verbal and visuospatial activities compete for a central pool of domain-general resources and, hence, that domain-general limits apply to human information processing. The present results are consistent with the predictions of theories proposing a pool of limited domain-general resources that supports various cognitive activities (e.g., Barrouillet et al., 2004; Kahneman, 1973) and fit nicely with the observed domain-general construct underlying working memory performance in individual differences studies (e.g., Kane et al., 2004; Kyllonen, 1993; Oberaurer et al., 2003). Our results present difficulties for theories that do not include a domain-general pool of limited resources supporting both verbal and visuospatial activities, such as on-line processing and storage (e.g., Baddeley, 1986; Duff & Logie, 2001; Shah & Miyake, 1996; Wickens, 1984). Accounting for the present results inevitably calls for a domain-general resource underlying both verbal and visuospatial activities.

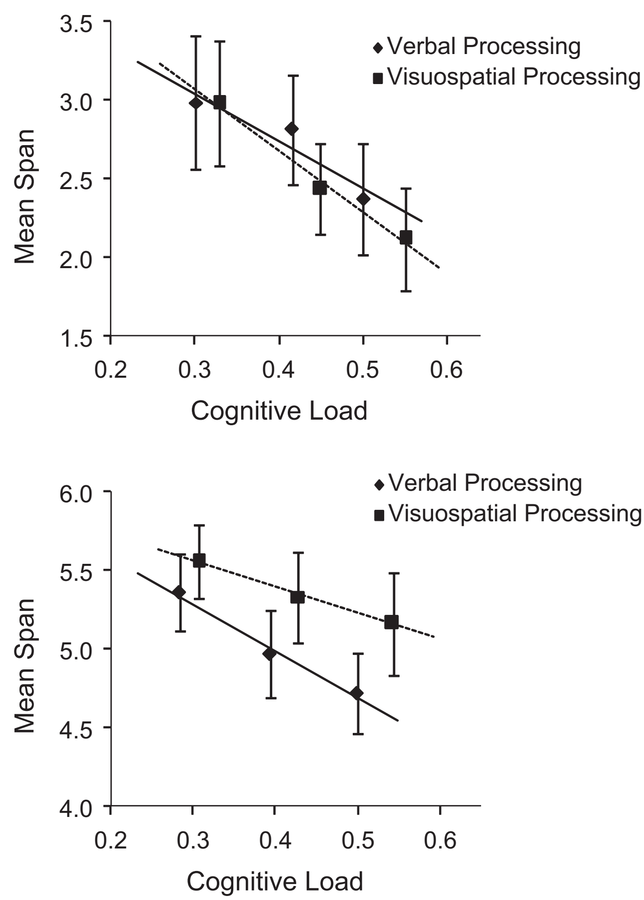

Fig. 1. Mean recall performance (i.e., span score) as a function of the observed cognitive load of the verbal and visuospatial processing tasks. Linear regression lines are provided for each combination of storage and processing task. Results for visuospatial recall are presented in the upper panel, and results for verbal recall are presented in the lower panel. Error bars represent 95% confidence intervals.

When interpreting the present observations of different-domain interference, one must bear in mind that they are based on crossing one processing task and one storage task in each domains. Accordingly, one could argue that our observations are task-specific, rather than the result of cross-domain resource sharing. It is important to note, however, that the storage tasks used in the present study are commonly used to assess verbal and visuospatial memory. In fact, we used storage tasks similar to those used in studies demonstrating domain-specific interference (e.g., Bayliss et al., 2003; Logie et al., 1990; Shah & Miyake, 1996). Furthermore, at least two findings strengthen the generality of the present cross-domain effects. First, it has been shown that visual recall performance (memory for colored disks) is disrupted by concurrent nonvisual activities, such as tone-pitch discrimination. Increasing the attentional demands of the discrimination task resulted in a larger dual-task decrement (Stevanovski & Jolicoeur, 2007). Second, in several studies of adults and children, we found verbal recall performance to decrease as the cognitive load of concurrent spatial processing (judging locations) increased (e.g., Barrouillet et al., 2007; Portrat, Barrouillet, & Camos, 2008; Portrat, Camos, & Barrouillet, 2009). These findings corroborate our interpretation that the present results indicate that verbal and visuospatial activities rely on a common pool of domain-general resources. We conclude that verbal and visuospatial activities such as maintenance can be disrupted by any concurrent activity that taps into this pool of domain-general resources.

However, the present results do not reveal only domain generality of limited resources underlying information processing activities. Although increasing the cognitive load of either verbal or visuospatial processing disrupted verbal storage, verbal recall performance was consistently poorer when it was combined with verbal processing than when it was combined with visuospatial processing. This indicates the presence of domain-specific interference within the verbal domain, over and above domain-general interference. No such domain-specific interference was observed within the visuospatial domain. It is possible that the representations of the verbal stimuli (the letters in the span task and the words in the semantic categorization task) overlapped with each other, whereas those of the visuospatial stimuli did not. However, it is rather hard to imagine why letters and words would overlap, but red squares and black squares would not.

A second possibility is that our verbal processing task (semantic categorization) involved some visuospatial processing. Indeed, participants may have generated visual representations of words to be categorized, a process that could have interfered with maintenance of locations in the location-span task. However, such an explanation is hard to reconcile with the fact that semantic categorization particularly disrupted verbal storage. Furthermore, we are not the first to observe a lack of domain-specific interference in the visuospatial domain. Bayliss et al. (2003) observed that verbal recall performance was worse when combined with verbal processing than when combined with visuospatial processing, whereas visuospatial recall performance was not affected by the nature of information concurrently processed.

Domain-specific interference between verbal activities may be explained by recent findings indicating that verbal information is maintained by two independent mechanisms: attentional refreshing and articulatory rehearsal (Camos, Lagner, & Barrouillet, 2009; Hudjetz & Oberauer, 2007). It is possible that verbal processing interfered with both mechanisms, whereas visuospatial processing interfered only with attentional refreshing. However, Cowan and Morey (2007) found that domain-specific effects in working memory were more prominent during encoding than during maintenance. Hence, it could be that verbal processing interfered with both encoding and maintenance of verbal information, whereas visuospatial processing interfered only with maintenance processes. Further research is needed to clarify this point.

Regarding the main point of the present study, our data indicate that human information processing activities are supported by central domain-general limited resources that have to be shared between two concurrent tasks. Accordingly, performing two tasks simultaneously can result in dual-task interference at a central level of the human information processing system, even when the tasks involve information or activities pertaining to different domains. Hence, in dual-task situations that occur in daily life, such as the use of a cell phone while driving, one has to consider the effect of central interference between the activities over and above more peripheral sources of interference. Consistent with this idea, recent research showed not only that driving performance is impaired by the concurrent use of a cell phone, but also demonstrated that the impairment is the same whether a handheld or a hands-free device is used, thereby ruling out more peripheral sources of interference, such as motor activities (Strayer & Johnston, 2001).

The observed trade-off relations establish the existence and importance of domain-general resources that have to be shared between two concurrent activities. Moreover, we demonstrated that this sharing takes place in a time-based way, one of the core assumptions of the TBRS model. Therefore, theorists of human information processing not only need to reconsider the domain generality of limited resources, but also need some explicit adaptations in order to fully account for the accumulating evidence that domain-general time-based resource sharing is one of the main mechanisms constraining working memory functioning and, more generally, human information processing.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interests with respect to their authorship and/or the publication of this article.

Supplemental Material

Additional supporting information may be found at http://pss.sagepub.com/content/by/supplemental-data

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