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    Sizing up the associative account of repetition priming

Authors: Ian Dennis · Hassina Carder · Timothy J. Perfect

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# Sizing up the associative account of repetition priming

## Abstract

Three studies which test an associative account of repetition priming in a size comparison task are reported. Congruence of decision between priming and test affected performance when the priming task and test tasks were the same but not when they differed. This congruence effect was unaffected by the proportion of trials with congruent responses. Same-task priming exceeded cross-task priming even when both tasks required the same aspect of semantic knowledge. The results indicate that a component of priming is due to associations which are formed during priming and automatically activated when stimuli are repeated at test. Stimuli do not become associated with motor responses but are associated with the results of processing at a number of other levels.
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Sizing up the associative account of repetition priming

Ian Dennis · Hassina Carder · Timothy J. Perfect

Abstract Three studies which test an associative account of repetition priming in a size comparison task are reported. Congruence of decision between priming and test affected performance when the priming task and test tasks were the same but not when they differed. This congruence effect was unaffected by the proportion of trials with congruent responses. Same-task priming exceeded cross-task priming even when both tasks required the same aspect of semantic knowledge. The results indicate that a component of priming is due to associations which are formed during priming and automatically activated when stimuli are repeated at test. Stimuli do not become associated with motor responses but are associated with the results of processing at a number of other levels.

Sizing up the associative account of repetition priming

A growing body of recent evidence supports the view that stimulus–response associations which are automatically formed, relatively durable and incidentally retrieved play an important role in a variety of situations involving repeated stimuli. This evidence derives from three different experimental paradigms—task switching, negative priming and repetition priming. Although each of these lines of evidence points to a role for an associative account of priming, it is not clear whether they are mutually coherent. This paper focuses on evidence deriving from the outcome congruence effect in repetition priming (Dennis & Schmidt, 2003) and asks whether it leads to a view of the properties of the associative mechanism which is consistent with that emerging from other lines of evidence. In particular, it will ask three questions concerning the associative process. First, is the encoding and retrieval of associations obligatory or strategic? Second, what exactly becomes associated with a stimulus (or in other words what do we mean by a ‘response’ when we talk about stimulus–response associations)? Third, are associations specific to the task on which they are formed?

Before considering the evidence that stimulus–response associations play a part in priming, two points of terminology must be dealt with. An important theoretical issue is whether stimuli become associated with motor responses or with the decisions that are their mental precursors. It is helpful if our terminology does not pre-judge this important question. This requires a term which can subsume both responses themselves and the decisions that lead to them. We will use the term outcome for this purpose. The second point of terminology relates to the label given to the general theoretical position under discussion. This position which incorporates the central associative principles of Logan’s (1988, 1990) Instance Theory and of Hommel’s (1998) concept of event files has been labelled response learning by Dobbins, Schnyer, Verfaellie and Schacter (2004) and response retrieval by Rothermund, Wentura, and de Houwer (2005). Each of these terms has the disadvantage of incorporating the word response, which we wish to avoid for the reasons just discussed and of focusing on just one of the two phases involved in the operation of the associative mechanism. To avoid these difficulties we will refer to the position under consideration as the associative account of priming.

One strand of recent evidence supporting the associative account comes from work on task-switching by Waszak...
and colleagues who have used the notion of stimulus-task-outcome bindings to explain why switch costs are greater for stimuli that have previously occurred in a competing task than for stimuli that have not, even if more than 100 trials have intervened since the occurrence (Waszak, Hommel & Allport, 2003, 2005). Similar theoretical ideas have been invoked in relation to negative priming by Rothermund et al. (2005), who argued that distracter stimuli on prime trials become associated with the outcome for that trial. An important feature of this account is that an element of a compound stimulus is independently associated with the outcome for the stimulus as a whole. In this respect it contrasts with earlier episodic accounts of negative priming (e.g. Neill, 1997) which suggested that the distracter on the prime trial becomes associated with non-responding.

In the repetition priming literature, Zeelenberg, Wagenmakers and Shiffrin (2004) (see also Wagenmakers, Zeelenberg, Steyvers, Shiffrin & Raajmakers, 2004) have noted that repetition of nonwords in a lexical decision task sometimes leads to facilitation and sometimes to inhibition. They argue that when facilitation occurs this is best explained through the formation of a memory trace on the priming trial that associates the letter string with its interpretation as a nonword. Other evidence supporting an associative account of repetition priming comes from Schnyer, Dobbins, Nicholls, Schacter and Verfaellie (2006) who examined the priming of decisions about whether objects presented as pictures were larger than a shoebox. When the test task was identical to the priming task, three priming trials produced more priming than a single priming trial. However, when the test task required participants to decide whether the object was smaller than a shoebox, so that the response made on the priming trials was no longer valid, the advantage of multiple priming trials disappeared. In a further study amnesics with medial temporal lobe damage showed no additional benefit from multiple priming trials. These results combined with functional imaging evidence (Dobbins et al., 2004) led the authors to conclude that the additional priming which occurred with multiple priming trials was entirely attributable to associative response learning and that this was impaired in the amnesic group.

An associative account has also been used to explain the outcome congruence effect in repetition priming reported by Dennis and Schmidt (2003). There are two key features of the situations in which this effect occurs. First, stimuli are presented in pairs and the task requires a response based on the relationship between the two members of a pair. Second, stimuli are re-paired between priming and test. Table 1 uses materials from “Experiment 1” in the present paper to illustrate this in relation to the size comparison task. In this task, which was previously used in Experiment 3 of Dennis and Schmidt (2003), participants are presented with two concrete nouns side by side on the computer screen and asked to respond by pressing a key on the same side as the word that refers to the larger object. In the primed pair (PP) condition the test pair exactly repeats a pair of nouns presented on a priming trial but two further conditions involve re-pairing words between priming and test. In the re-pair conclusion congruent (RCC) condition the conclusions concerning each word’s relative size are congruent between priming and test trials so that the larger item on the priming trial remains the larger item when it appears on a test trial and similarly the smaller item at test is also the smaller item previously. In the re-pair conclusion mismatch (RCMM) condition the reverse applies—the larger item on the priming trial becomes the smaller item on the test trial and vice versa. Dennis and Schmidt found that responses were faster and more accurate in the RCC condition (which they refer to as re-pair match) than in the RCMM condition (which they refer to as re-pair mismatch). A similar effect also occurred in two other experiments in which the task required judgements of synonymy. We will refer to this difference between RCC and RCMM as the outcome congruence effect. The associative account of the effect proposes that on the priming trial each of the words making up the priming pair becomes associated with an outcome of

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Table 1: Example materials for "Experiment 1" and an illustration of the conditions used

<table>
<thead>
<tr>
<th>Condition</th>
<th>Control</th>
<th>Primed pair</th>
<th>Re-pair conclusion congruent</th>
<th>Re-pair conclusion mismatch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeated-side</td>
<td>River porpoise arena atlas</td>
<td>Teaspoon pumpkin arena atlas</td>
<td>Teaspoon hacksaw comb pumpkin</td>
<td>Teaspoon blackcurrant wagon pumpkin</td>
</tr>
<tr>
<td>Priming pairs</td>
<td>Teaspoon pumpkin</td>
<td>Teaspoon pumpkin</td>
<td>Teaspoon pumpkin</td>
<td>Teaspoon pumpkin</td>
</tr>
<tr>
<td>Test pair</td>
<td>Teaspoon pumpkin</td>
<td>Teaspoon pumpkin</td>
<td>Teaspoon pumpkin</td>
<td>Teaspoon pumpkin</td>
</tr>
<tr>
<td>Switched-side</td>
<td>River porpoise arena atlas</td>
<td>Teaspoon pumpkin arena atlas</td>
<td>Teaspoon hacksaw comb pumpkin</td>
<td>Teaspoon blackcurrant wagon pumpkin</td>
</tr>
<tr>
<td>Priming pairs</td>
<td>Teaspoon pumpkin</td>
<td>Teaspoon pumpkin</td>
<td>Teaspoon pumpkin</td>
<td>Teaspoon pumpkin</td>
</tr>
<tr>
<td>Test pair</td>
<td>Pumpkin teaspoon</td>
<td>Pumpkin teaspoon</td>
<td>Pumpkin teaspoon</td>
<td>Pumpkin teaspoon</td>
</tr>
</tbody>
</table>

The underlined item in each pair represents the correct response.
processing on that trial. This outcome, which might be a conclusion concerning the word’s relative size or might be a motor response, is then automatically retrieved on the test trial. The retrieved outcome will be valid and helpful in RCC and inappropriate in RCMM, thus leading to the observed difference between these two conditions.

Having briefly considered a number of different lines of evidence for the associative account of priming we now turn to the issue of whether these different lines of evidence are mutually consistent in terms of their implications for the properties of the associative mechanism. We will first briefly consider what the existing evidence has to say about this question and then report three studies designed to address it further.

In the studies reported by Dennis and Schmidt (2003) each priming word appeared only once and around 20 trials intervened between the relevant primes and the test pair. An associative account of the outcome congruence effect therefore needs to assume that a single presentation is sufficient to establish associations which can survive this sort of delay. Many of the studies cited above use more than one priming trial for each stimulus but when evidence for stimulus–response associations following a single priming trial has been sought it has usually been found. Waszak et al. (2003, Experiment 2) showed increased switch costs following a single priming trial with at least 12 trials between prime and test. Likewise Schnyer et al. found that inverting the size judgement task at test led to a reduction in priming even after a single priming trial. In this respect then, evidence from other paradigms is compatible with an explanation of outcome congruence in terms of associations formed after a single priming trial.

When outcome congruence is demonstrated words are re-paired between priming and test. Words making up test pairs in the two critical conditions are derived from separate priming trials. Thus the associative account of the effect requires that the outcome on the priming trial is separately associated with each of the two component words of the priming pair and not just with the intact pair. Consistent with this assumption, Waszak et al. (2005) found that cross-task priming effects on switch trials were still obtained when picture-word pairs were re-paired between priming and test. Similarly, Rothermund et al.’s (2005) account of negative priming proposes that in a priming trial containing both a distracter and a target, the distracter becomes independently associated with the response. Support for this aspect of their account comes from their Experiment 4 using a letter matching task in which letters which served as distracters in the prime became targets in the probe. This led to inhibition when the prime and probe response differed but not when they matched. Logan and Etherton (1994) carried out a study in which participants determined whether or not a two word display contained a member of a target semantic category. Words were re-paired between training and test so that at test non-targets could either appear in a pair requiring the same response as that in which they occurred during training or in one requiring the opposite response. Opposite responses were slower than matching responses, again in line with the assumption of independent response associations for each member of a pair. Thus evidence across a variety of paradigms supports the assumption that both elements of a two component stimulus become associated with the outcome for that stimulus.

The first aim of the experiments reported in this paper is to ask whether the properties of the outcome congruence effect are compatible with existing evidence on the associative mechanism in three further respects: (a) the obligatory encoding and retrieval of associations, (b) the nature of the response that is associated with a stimulus and (c) the task specificity of associations. In relation to the first of these properties Logan’s (1988, 1990) Instance Theory proposes that both the formation and retrieval of stimulus–response associations are obligatory. “Experiment 1” investigates whether the behaviour of the outcome congruence effect accords with this position or whether on the contrary it is strategically moderated and also considers the nature of the responses associated with a stimulus thus addressing property (b) above. Experiments 2 and 3 focus on property (c) and consider whether the outcome congruence effect is a task-specific effect.

**Experiment 1**

Logan’s (1990) Instance Theory claims that both the formation and retrieval of stimulus–response associations are obligatory and not under strategic control. Both negative priming and enhanced switch costs for stimuli that have previously occurred in a competing task involve impairments of performance attributable to the associative mechanism. This indicates that associative priming processes continue to operate even when they hinder performance. In contrast, the outcome congruence effect has so far only been demonstrated in a context in which response retrieval is helpful to performance. However, if the effect depends on the same associative mechanisms then it should also be seen in experimental contexts in which response retrieval is not helpful to performance.

All three experiments reported by Dennis and Schmidt (2003) included a primed pair condition (illustrated in Table 1) as well as the RCC and RCMM conditions. In both the primed pair and RCC condition the conclusion reached about a word on the priming trial matched that on the test trial. Hence, in these studies, trials with matching conclusions were more frequent than trials with mismatching...
conclusions. This balance of trials makes the retrieval of the conclusion from the priming trial an adaptive strategy for the experimental context. The first aim of “Experiment 1” was to investigate whether the effect is still obtained in a situation where relying on a retrieved conclusion is no longer advantageous. Each participant served for two experimental sessions. One of the sessions included a primed pair condition as well as the RCC, RCMM, and control conditions. In the other session there were no primed pairs. Instead these were replaced with word pairs which had not previously appeared and acted as filler trials. In the session including primed pairs test trials for which the retrieval of a previous conclusion led to the correct response were twice as common as test trials where it led to the wrong response whereas in the other session without primed pairs both types of trial were equally frequent. If the outcome congruence effect is contextually moderated by the presence of a majority of items requiring a matching response then it would be expected to be larger when the primed pair condition is present than when it is omitted. If the effect is purely stimulus driven then it should be the same in both conditions.

The second issue addressed in “Experiment 1” was whether stimuli become associated with motor responses or with the decisions that are their mental precursors. Logan (1990) found that in a lexical decision task varying the mapping of decisions (word vs. non-word) on to response keys did not disrupt priming and concluded that it is task-based decisions rather than motor responses that are associated with stimuli. Experiments using the task-switching paradigm have reinforced this conclusion. Contrary to what would be expected if associations with motor responses were involved, switch costs for primed stimuli are just as great when they require identical responses in both tasks as when they do not (Koch & Allport, 2006; Waszak et al., 2003). Further evidence comes from negative priming. As Rothermund et al.(2005) have noted an account involving associations with overt responses cannot explain demonstrations of negative priming when there is no response on the priming trial.

In contrast, some evidence for associations with motor responses was reported by Dobbins et al. (2004) who found that switching the mapping of the responses ‘yes’ and ‘no’ to keys on the test trial reduced priming in the same way as inverting the task and changing the required decision. However, as pointed out by Schnyer, Dobbins, Nicholls, Davis, Verfaellie and Schacter (2007), the design used by Dobbins et al. tests the two mapping conditions after different numbers of trials. The study by Schnyer et al. used the same classification task but eliminated this confound and showed no effect on priming of reversing the response mapping. Overall the majority of the evidence suggests that associations with motor responses typically have little or no role to play and that associations are primarily between stimuli and decisions. “Experiment 1” investigated whether an associative account of outcome congruence leads to the same conclusion about the nature of the associations involved.

The three primed conditions of “Experiment 1” included two types of test trial as illustrated in Table 1. The words making up the test pair either both appeared on the same side as they did in priming trials or both appeared on the opposite side to that of their earlier appearance. These two types of trial will be referred to as repeated side and switched-side trials, respectively. Inspection of Table 1 shows that switched-side trials reverse the confounding of congruence of finger presses with congruence of conclusions about which an object is the larger member of the pair. On switched-side trials the RCC condition involves congruent conclusions with those on priming trials but incongruent finger presses, conversely the RCMM condition involves incongruent conclusions but congruent finger presses. Experiment 3 of Dennis and Schmidt (2003) demonstrated the outcome congruence effect with an approximately equal frequency of repeated side and switched-side trials and argued that the effect was due to congruence of conclusions rather than congruence of physical responses. However, motor response learning and conclusion learning are not necessarily mutually exclusive possibilities and both may contribute to the effect. If this is so then on repeated side trials these two components of the effect will act in the same direction and summate but on switch trials they will act in opposition. Thus the second aim of “Experiment 1” was to ascertain whether any part of the outcome congruence effect can be attributed to the association of finger presses with stimuli by comparing results with repeated side and switched-side pairs.

Method

Participants

The final sample consisted of 80 adults from the University of Plymouth volunteer participation pool who took part in return for course credit or cash payment. Four original participants were replaced, one failed to complete both sessions, one had an overall error rate in excess of 25% and two had an overall mean reaction time (RT) that was more than two standard deviations above the group mean.

Design

Participants completed two sessions. To manipulate the effect of context, one session contained the prime pair condition and the other did not, the order of the two contexts was counterbalanced across participants. There were two sets of stimuli and the assignment of these two sets to the two context conditions was also counterbalanced.
Each session began with 15 practice trials following which there were 17 blocks of 16 trials each. Each block except the first contained four critical pairs. There was one critical pair from each of the control, RCC and RCMM conditions. The fourth critical pair was either a primed pair or a second control pair according to the type of session. The primes for the critical pairs appeared in the preceding block. Therefore, in blocks 2–16 there were four critical pairs, eight pairs of words to prime the critical pairs of the subsequent block, and four filler trials. In block 1 critical pairs were replaced with additional filler trials, and in block 17 priming pairs were replaced with filler trials. Within each block, trials were randomised but the embedded structure was identical for all participants. For a given stimulus set all participants received the same critical pairs in the same positions in the trial sequence. However, the condition that the critical pair belonged to varied and was determined by previous priming events. The assignment of critical pairs to conditions was counterbalanced across participants. When primed pairs were present each participant received a quarter of the critical pairs in each of four conditions (Control, PP, RCC and RCMM), and each critical pair was used in each condition for a quarter of the participants. For sessions with no primed pairs a second set of control stimuli was used to maintain counterbalancing. Half of the critical pairs always appeared as repeated-side pairs, in other words whenever they were primed the previous presentation of each word was always on the same side as in the test pair. The other half of the critical pairs always appeared as switched-side pairs in which both words changed sides between priming and test. Half of the correct responses to critical trials appeared on the right, and half on the left, and these were assigned randomly. Within-block randomisation conformed to two conditions—there were no critical trials in the first four trials, and no primes appeared in the last four trials in a block. Furthermore, the two primes for any critical pair were never separated by more than three other pairs. The blocking arrangement was not signalled to participants, from whose perspective the stimuli appeared as a single sequence of 272 trials.

To generate the stimulus pairs that were presented, sets of six nouns that referred to concrete objects were compiled. Most were single words but some were two or three word compound nouns. The sets showed a progressive increase in typical size such that each set was structured so that word A < word B < word C < word D < word E < word F. All critical trials consisted of words B&E in a word set. The primes for the prime pair critical trials consisted of words B&E, and D&E. The primes for the RCC critical trials consisted of words B&C and D&E, so that word B was always the smaller during both priming and critical trials, and word E was always the larger. The primes for RCMM critical trials consisted of words A&B and E&F, so in this case the word that was larger in the priming trial became the word that was smaller in the critical trial. The unrelated primes for the control condition were made up of words A&C and D&F. Control primes, filler trials and unrelated primes for the primed pair critical trials consisted of unique words that were never re-presented.

Procedure

Participants were tested sitting at a computer in a booth. They were told that they would be asked to judge which of two words presented on the screen corresponded to the larger object, and were asked to give their informed consent. Instructions presented on the computer screen informed them that if the larger object was on the left they should press the D key on the keyboard, and if the larger object was presented on the right they should press the L key. These keys were marked with coloured stickers. Participants were asked to respond with their left or right first finger, to keep these fingers lightly rested on the keys throughout and to respond as quickly as possible without making mistakes. RTs for correct responses were displayed at the end of the trial and participants were asked to try to make these times as short as possible.

Each trial began with an asterisk presented in the centre of the screen for 1,000 ms. The screen then went blank for 500 ms after which a pair of words was presented in 24 point lowercase Gill Sans MT Condensed font. These words were left and right aligned 1.5 cm on either side of the position where the asterisk had appeared. The word pair remained on screen until the participant responded or for a maximum of 5,000 ms. If the response was correct then the RT appeared for 1,000 ms, before the next trial began. If the response was incorrect then the message “Wrong” appeared on the screen for 4,000 ms.

Each of the two sessions lasted about 30 min and contained 272 experimental trials preceded by 15 practice trials. After 136 experimental trials a 2-min rest break was given. The interval between the two sessions varied across participants between 1 day and 2 weeks.

Results

Table 2 shows means of participants’ RTs and error rates for each condition both when primed pairs were present and when they were absent. RTs for each participant in each condition were determined by applying Tukey’s biweight estimator (Mosteller & Tukey, 1977) to the logarithms of latencies for correct responses only. The biweight estimator was created to combine robustness and efficiency in estimating central tendency. Responses with latencies below 400 ms were discounted as anticipations, which led to 0.20% of trials being discarded.
ANOVA was carried out with two repeated measures factors—condition with three levels (control, RCC and RCMM) and context with two levels (with or without primed pairs). The order of the two contexts, the alternative assignments of critical pairs to conditions, and the two alternative pairings of stimulus sets with contexts were between-participant factors. Between-participants factors relating to the assignment of materials to conditions were included in all the ANOVAs reported in this paper. Significant effects involving such factors, which are due to differences in speed or accuracy of responding to different sets of critical pairs, are not of substantive interest and are not reported below but including these factors reduces error variance and increases power (Pollatsek & Well, 1995). In this and subsequent ANOVAs Greenehouse-Geisser adjusted degrees of freedom are used when appropriate.

ANOVA showed a main effect of condition for both RTs, \(F(1, 109.1) = 103.7, \text{MSE} = 8,296, P < 0.001\) and error rates, \(F(2, 127.9) = 31.4, \text{MSE} = 18.4, P < 0.001\). There was no interaction between condition and context either for latencies, \(F(1.99, 127.3) = 1.28, \text{MSE} = 4,251, P = 0.28\) or for error rates, \(F(1.7, 112.2) = 0.6, \text{MSE} = 18.6, P = 0.56\) showing that the presence of primed pairs did not affect the size of the outcome congruence effect. Also there was no three way interaction between order, context and condition for either latencies \(F(2, 127.3) = 1.6, \text{MSE} = 4,251, P = 0.21\) or errors \(F(1.7, 112.2) = 0.57, P = 0.74\), \(\text{MSE} = 18.6\). Sidak adjusted pairwise comparisons on the main effect of condition showed that the RCC condition produced significantly faster responses than RCMM \((P < 0.001)\) and that both produced faster responses than control \((P < 0.001 \text{ in both cases})\). The error rates for all three conditions were also significantly different. The RCC condition gave rise to fewer errors than both control \((P < 0.001)\) and RCMM \((P < 0.001)\) whilst RCMM produced a higher error rate than the control \((P = 0.002)\). For latencies there was also a significant context by order interaction, \(F(1, 64) = 8.23, \text{MSE} = 1,0251, P = 0.006\) which simply indicated that responses were faster in the second session than the first.

The data provide two tests of whether associations between stimuli and motor responses play any part in repetition priming. The first test is based on whether or not outcome congruence varies between the switch and non-switch conditions. Given the absence of context effects in the preceding analysis data from the two contexts was combined for the purpose of this test. The resultant mean RTs and error rates are shown in the first three columns of Table 3. The issue of interest is whether or not the outcome congruence effect varies between the repeated-side and switched-side conditions. In order to examine this ANOVA was carried out on the data from the RCC and RCMM conditions, using condition (RCC vs. RCMM) and side (repeated vs. switched) as the two repeated measures factors. This showed the expected main effect of condition both for RTs \(F(1, 76) = 44.8, \text{MSE} = 5,604, P < 0.001\) and for errors \(F(1, 76) = 69.1, \text{MSE} = 16.1, P < 0.001\). More important is the interaction of condition with the side factor. This interaction was not significant for RTs \(F(1, 76) = 2.49, \text{MSE} = 5,486, P = 0.12\) and although error rates showed a trend whereby the effect of outcome congruence was smaller in the switched-side condition this also fell marginally short of significance, \(F(1, 76) = 3.73, \text{MSE} = 27.3, P = 0.057\). A second test of whether associations with motor responses have a role is provided by comparing the amount of priming seen with primed pairs in the repeated-side and switched-side conditions. In order to carry out this test it is necessary to compare data from primed pairs with those from control pairs presented in the same session. These data are shown in the final two columns of Table 3. Critically ANOVA using condition (primed pair vs. control) and repeated-side versus switched-side as factors showed no interaction between these two factors either for RTs \(F(1,72) = 0.327, \text{MSE} = 10,026, P = 0.57\) or for errors \(F(1,72) = 0.44, \text{MSE} = 34.7, P = 0.51\).

### Table 2 Reaction times and error rates in each of the two contexts in “Experiment 1”

<table>
<thead>
<tr>
<th></th>
<th>Primed pair</th>
<th>Control</th>
<th>Re-pair conclusion congruent</th>
<th>Re-pair conclusion mismatch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Without primed pairs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT (ms)</td>
<td>1,104 (202)</td>
<td>958 (161)</td>
<td>1,013 (189)</td>
<td></td>
</tr>
<tr>
<td>% Error</td>
<td>3.8 (5.3)</td>
<td>1.8 (4.1)</td>
<td>5.5 (5.5)</td>
<td></td>
</tr>
<tr>
<td><strong>With primed pairs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT (ms)</td>
<td>931 (165)</td>
<td>1,076 (205)</td>
<td>954 (171)</td>
<td>1,001 (163)</td>
</tr>
<tr>
<td>% Error</td>
<td>3.4 (5.4)</td>
<td>2.8 (4.7)</td>
<td>1.5 (3.6)</td>
<td>5.4 (5.7)</td>
</tr>
</tbody>
</table>

Figures in parentheses are between-participant standard deviations.

### Table 3 Reaction times and error rates for repeated-side and switched-side trials in “Experiment 1”

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Re-pair conclusion congruent</th>
<th>Re-pair conclusion mismatch</th>
<th>Control</th>
<th>Re-pair conclusion congruent</th>
<th>Re-pair conclusion mismatch</th>
<th>Primed pair</th>
<th>Re-pair present</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Repeated-side</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT (ms)</td>
<td>1,077</td>
<td>947</td>
<td>1,016</td>
<td>1,073</td>
<td>922</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Error</td>
<td>2.6</td>
<td>1.2</td>
<td>6.0</td>
<td>2.1</td>
<td>2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Switched-side</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT (ms)</td>
<td>1,111</td>
<td>979</td>
<td>1,022</td>
<td>1,088</td>
<td>950</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Error</td>
<td>3.8</td>
<td>2.0</td>
<td>4.6</td>
<td>3.3</td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Statistics in the first three columns are based on all sessions whereas those in the final two columns are derived only from sessions where primed pairs were present.
Discussion

“Experiment 1” provided a clear replication of the outcome congruence effect. Responses in the RCC condition were both faster and more accurate than those in the RCM condition. One aim of the study was to determine whether the effect is sensitive to the proportion of trials on which conclusions reached on previous trials using the same words matched those required on the test trials. The results in relation to this aim are clear. The effect obtained in a context which included primed pairs, so that matching conclusions were more frequent than mismatching conclusions, was no larger than that obtained when primed pairs were omitted so that matching and mismatching conclusion were equally frequent. It is possible that a participant encounters primed pairs in their first session any strategy which these induce may carry over into the second session even if the latter does not include primed pairs. This possibility was evaluated by considering only data from the first session. The outcome congruence effect was present and of a similar size in the first session data from both groups (for participants who encountered primed pairs in the first session the RT effect was 33 ms and the error effect was 4.2%, for those who did not the RT effect was 45 ms and the error effect was 3.9%). This is reinforced statistically by the absence of a three way interaction between condition, context and order.

Hence, it seems safe to conclude that the processes leading to the outcome congruence effect are automatic in the sense that they occur even in contexts in which there is no net benefit across all trials from relying on previous conclusions. This outcome is compatible with an explanation of the outcome congruence effect in terms of Instance Theory which claims that both the encoding of stimulus–response associations and their retrieval on priming trials are obligatory. It also implies that in this respect, at least, an associative account of outcome congruence is compatible with similar associative accounts of task switching and negative priming in which associative processes are postulated to occur even in situations where they harm performance.

The second aim of “Experiment 1” was to investigate whether associations between stimuli and motor responses play any part in repetition priming by comparing the repeated–side and switched–side conditions. The outcome congruence effect on latencies showed no attenuation in the switched–side condition and although there was a suggestion that the error effect was smaller in this condition the relevant interaction fell slightly short of significance. The effect of switching the two words in the test pair (and thus the motor response) was also examined in the primed pair condition. Latency facilitation for primed pairs was no smaller in the switched–side condition than in the repeated–side condition and there was also no interaction in the error data (although this last finding is qualified by the fact that the error rate was actually non–significantly higher in the primed pair condition than in the control condition).

Thus for the most part the associations giving rise to the outcome congruence effect seem to involve the mental precursors of overt responses—conclusions about words in the context of a particular task. Associations between stimuli and motor responses appear to make little or no contribution to the effects observed in this study. This conclusion is consonant with the evidence from other paradigms considered in the introduction to this experiment.

Experiment 2

“Experiment 2” was directed towards the issue of task specificity. The evidence from standard repetition priming paradigms suggests that associations are specific to the task on which they are formed and that only associations formed in the context of the current task are active. For example Dobbins et al. (2004), Schnyer et al. (2006) and Schnyer et al. (2007) all find that when the test task is the inverse of the priming task multiple priming trials produce no more priming than a single priming trial. In contrast when the test task and priming tasks are identical multiple priming trials lead to enhanced priming. They attribute these findings to the fact that the associative mechanism does not operate in the cross-task situation (even though, in this case, the response on the inverted task has a determinate relationship to that on the standard task). Similarly, Zeelenberg et al. (2004, Experiment 1) showed a facilitatory effect for nonwords in lexical decision when these had been primed in a lexical decision task but an inhibitory effect when the previous occurrence was in a letter height task. This again suggests that facilitation derives from associations which are only activated in the same-task case.

Hence existing evidence suggests that, providing participants carry out the same task over many trials, associations formed on one task will not be re-activated on another. There is, however, an obvious problem with this position. If repetition priming is solely due to the associative mechanism and if associations are specific to the task on which they are formed then repetition priming should not occur when the priming task and test task are different. Despite occasional failures to find significant repetition priming across tasks (e.g. Franks, Bilbrey, Lien & McNamara, 2000, Experiments 3, 4 and 6; Thompson–Schill & Gabrieli, 1999, Experiment 1; Vriezen, Moscovitch & Bellos, 1995, Experiments 1, 3 and 4;) it has much more frequently been found that some cross-task priming does occur (e.g. Franks et al., 2000, Experiments 8, 10, 11, 12 and 13; Ratcliffe, Hockley & McKoon, 1985, Experiment 1; Scarborough, Gerard and Cortese, 1979; Thompson–Schill &
**Psychological Research**

Gabrieli, 1999; Vaidya et al., 1997, Experiment 5; Vriezen et al. 1995 Experiments 3 to 6; Experiments 2 and 4). However, this is only problematic for the suggestion that associations are task-specific if it is also claimed that all repetition priming is due to the associative mechanism. Otherwise cross-task priming can be attributed to other components of priming aside from the associative component.

“Experiment 2” aimed to test the claim that associations are task-specific whilst allowing for the possibility that the associative process may only be one of several priming mechanisms. Two predictions deriving from task-specificity were examined. First, there should be no outcome congruence effect in a condition in which participants are primed on one task and tested on another. Second within-task priming, where the associative aspect augments any other components of priming, should always be larger than cross-task priming, no matter how similar the perceptual and semantic requirements of the two tasks. Existing demonstrations that same-task priming exceeds cross-task priming typically use two tasks which involve different semantic domains (e.g. Bowers & Turner, 2003; Bruce, Carson, Burton & Ellis, 2000; Thompson-Schill & Gabrieli, 1999; Experiments 2 and 4; Vriezen et al., 1995, Experiments 6, 1). Such results can be explained without resort to an associative account by invoking the activation of a specific area of semantic knowledge (Thompson-Schill & Gabrieli, 1999). In order to provide a more specific test of the proposal that associations are task-specific, “Experiment 2” combined the size comparison task with a second task based on the size of objects.

“Experiment 2” used the size comparison task to test the two predictions set out above. It employed a repetition priming paradigm in which participants carried out the same task throughout a block of trials and incorporated a cross-task condition which made it possible to determine whether performance on the test trial was dependent on the response made on the priming trial. In order to produce a response uncorrelated with that of the size comparison task, “Experiment 2” used a second task in which participants were required to decide which of the two objects was closer in size to a football whilst in the other they had to decide which was typically larger. Priming with the football task preceded priming with the size comparison task for half the participants and for the other half this order was reversed. Each priming block consisted of 55 trials, of which the first 15 were practice trials. For all participants the two priming blocks were followed by a final test block using the size comparison task.

The test block, which was identical for all participants, was composed of 15 practice trials followed by 120 test trials. Of these test trials, 40 had previously appeared in the size comparison priming block, 40 had been primed in the football task and the final 40 were unprimed pairs that had not previously been seen. The pairs appearing in the priming blocks were varied across participants so that each test pair appeared in each condition for one-third of the participants. Half of the noun pairs were L = C pairs and half were S = C pairs. Half of the test pairs required a right hand response and half required a left hand response. For half of the pairs that had appeared previously the two words remained on their original sides whilst for the remaining half the sides were reversed.

**Procedure**

General aspects of the testing procedure and instructions were the same as for “Experiment 1”. Participants were told that they would be asked to make judgements about pairs of words presented on the screen and that there would be three pairs the size comparison task and the football task both require participants to respond to the same word but for S = C pairs the two tasks require opposite responses. Comparison of priming on these two types of word pair indicates whether outcome congruence has any effect when the priming task and test task differ.

**Method**

**Participants**

Participants were drawn from the University of Plymouth participation pool and took part in return for course credit or cash payment. Two participants with error rates in excess of 25% and two participants with overall mean RTs more than two standard deviations above the group mean were replaced. Three further participants were randomly discarded to maintain counterbalancing, leaving 54 participants from whom data are reported.

**Design**

There were two priming blocks. In one of these participants had to judge which of the two objects was closer in size to a football whilst in the other they had to decide which was typically larger. Priming with the football task preceded priming with the size comparison task for half the participants and for the other half this order was reversed. Each priming block consisted of 55 trials, of which the first 15 were practice trials. For all participants the two priming blocks were followed by a final test block using the size comparison task.

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blocks of trials which would vary in the judgement required. Each block was preceded by instructions appropriate to the relevant task. For both tasks the two nouns were presented side by side on the computer screen and participants were instructed to respond with a key on the same side as the noun which met the decision criterion. The detailed events on each trial were the same for all trials and identical to those in “Experiment 1”. The testing session lasted about 30 min.

Results

The data were processed using the same procedures as for “Experiment 1”. Only 0.02% of all trials led to latencies below the 400 ms threshold for anticipations. In line with the results of “Experiment 1” there was no evidence of priming being modified by whether or not the two words making up a word pair switched sides between their first appearance and test, so in the interests of simplicity and brevity the data reported are aggregated across these two conditions. Overall mean latencies and error rates for critical pairs in the final test block are shown in Table 4. ANOVA was carried out with condition (control vs. same-task primed vs. cross-task primed) and type of word pair (L = C vs. S = C) as repeated measures factors and alternative assignments of critical pairs to conditions as a between-participants factor. There was a main effect of condition for both latencies $F(1.5,70.7) = 59.3$, MSE = 12,492, $P < 0.001$, and errors $F(1.9, 89.8) = 16.7$, MSE = 50.8, $P < 0.001$. There was no significant difference in RTs between the two types of word pair, $F(1, 48) = 1.60$, MSE = 3,619, $P = 0.21$, but S = C pairs produced more errors than L = C pairs, $F(1, 48) = 12.3$, MSE = 411, $P = 0.001$. More importantly there was no significant interaction between Condition and type of word pair on RTs, $F(1.8, 87.6) = 0.31$, MSE = 9,877, $P = 0.72$, and, despite a suggestion that cross-task priming increases the error difference between S = C and L = C, the interaction for errors also fails to reach significance, $F(1.9, 93.8) = 2.56$, MSE = 46.9, $P = 0.08$. Sidak adjusted pairwise comparisons on the main effect of condition showed that all three conditions differed from each other both on latencies ($P < 0.001$ in all three cases) and errors ($P < 0.001$ for unprimed vs. same-task primed, $P = 0.018$ for unprimed versus cross-task primed, $P = 0.007$ for same-task primed versus cross-task primed).

Discussion

In the same-task condition the selected object at test inevitably matches that on the priming trial for both types of word pair. However, in the cross-task conditions it matches for L = C pairs but it mismatches for S = C pairs. If outcome congruence affects priming in the cross-task condition then there should be less priming on S = C pairs than on L = C pairs leading to an interaction between condition and type of word pair. There was no evidence of this interaction on latencies, and although the error data showed a trend in the appropriate direction that fell short of significance. Thus the results suggest that outcome congruence does not affect cross-task priming. This finding contrasts with the results of “Experiment 1” and other demonstrations of the outcome congruence effect in same-task priming suggesting that at least under the conditions of this study stimulus-outcome associations are only activated on the task on which they were formed. This conclusion is consistent with Dobbins et al. (2004) and Schnyer et al. (2006) who argued that associations formed when deciding whether an object was smaller than a shoebox did not affect performance on the inverse task. The lack of effect from associations formed on a different task may be because the information which is bound to a stimulus is task specific (e.g. the conclusion that ‘X is closer in size to a football’ is irrelevant if the current task is to decide which object is larger) or because part of what is involved in adopting a particular task set is to activate associations which are relevant to that task.

It should not, however, be concluded from “Experiment 2” that associations can never be activated on a task different from that on which they are formed. Evidence to the contrary comes from the work of Waszak et al. (2003) on task switching who find that switch costs are greater for stimuli that have previously appeared in the alternate task than for those that have only been used in the task which is operative on the current trial. The results of Rothermund et al. (2005, Experiments 1–3) also indicate that associations formed on one task can affect performance on another. They used a negative priming paradigm in which a prime trial on one task was immediately followed by a probe trial using a different task. The effects of repeating the prime distracter in the probe depended on whether the response required on the two trials was the same or different. Negative

### Table 4 Reaction times and error rates in the final test block of “Experiment 2”

<table>
<thead>
<tr>
<th>Condition</th>
<th>Size comparison primed (same-task)</th>
<th>Football task primed (cross-task)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smaller is closer (S = C)</td>
<td>RT (ms) 1,193 (257)</td>
<td>RT (ms) 1,193 (258)</td>
</tr>
<tr>
<td>% Error</td>
<td>14.5 (9.6)</td>
<td>13.1 (8.3)</td>
</tr>
<tr>
<td>Larger is closer (L = C)</td>
<td>RT (ms) 1,063 (182)</td>
<td>RT (ms) 1,044 (173)</td>
</tr>
<tr>
<td>% Error</td>
<td>8.8 (6.5)</td>
<td>8.0 (7.4)</td>
</tr>
</tbody>
</table>

For L = C pairs both tasks require the same response, for S = C pairs the two tasks require opposite responses. Figures in parentheses are between-participant standard deviations.
priming was observed when the prime and probe required
different responses but positive priming resulted when they
led to the same response. Two pieces of evidence suggest
that the critical difference between “Experiment 2” and
studies in which associations do appear to operate across
tasks is that in the former people carry out the same task
throughout a block of trials whereas in the latter partici-
pants repeatedly alternate between the two tasks involved.
This explanation is supported firstly by the fact that the
effects found by Waszak et al. (2003) were largely confined
to switch trials. Second, Waszak and Hommel (2007) have
directly demonstrated that cross-task priming effects are
quite different when the test block contains alternating trials
on two different tasks than when all the trials use the same
task. Overall the evidence is consistent with the proposal
that when people are engaged in a single task and have a
stable task set only the associations formed on that task will
be operative. In contrast when people repeatedly switch
between tasks associations may still operate on the opposite
task to that on which they are formed.

The two tasks used in “Experiment 2” were chosen so
that both had the same word-identification requirements
and relied on the same semantic knowledge. Despite this
there was substantially greater priming in the same-task
condition than in the cross-task condition. Similar results
have been obtained by Schnyer et al. (2006) who found that
even with a single priming trial deciding whether an object
is larger than a shoebox primes the same task to a greater
extent than it primes the inverted task of deciding whether
the object is smaller than a shoebox. Such results are
entirely understandable if one component of same-task
priming comes from the associative retrieval of previous
conclusions and if this retrieval does not take place in the
cross-task case. The cross-task priming which was
observed in “Experiment 2” as well as many other studies
referred to in the Introduction can be explained by other
non-associative components of priming. This multi-compo-
nent view of priming is discussed further below in the
Introduction to “Experiment 3”.

The difference between same-task and cross-task prim-
ing might alternatively be attributed to the principle of
transfer appropriate processing (TAP) (Morris, Bransford
& Franks, 1977). As it has been applied to repetition prim-
ing this asserts that priming occurs to the extent that the
mental processes required on the test trial overlap with
those on the priming trial. The two tasks used in “Experi-
ment 2” differ in the comparison and decision processes
required and thus there will inevitably be more process
overlap in the same-task case. Rothermund et al. (2005)
have argued that the associative account of priming
becomes subsumed under TAP if the response involved is
conceived of more broadly than simply as an overt motor
action. In this context the issue of the relationship between
an associative account and TAP is considered further in the
general discussion.

“Experiment 2” suggests that in repetition priming stud-
ies using large blocks of trials all involving the same task,
automatic retrieval of previous outcomes only takes place
when the priming and test tasks are the same. “Experiment
3” provided a further test of this task-specificity and addi-
tionally followed up a result from “Experiment 1” which
causes some problems for an associative account of the out-
come congruence effect. This is the finding that the RCM
condition shows latency facilitation relative to an unprimed
control, rather than inhibition as a simple associative
account of outcome congruence would appear to suggest.

Experiment 3

Experiments 1 and 2 help to strengthen support for an asso-
ciative account of the outcome congruence effect by show-
ing that the properties of the effect are consistent with the
properties of the associative mechanism inferred from other
lines of evidence. However, both in “Experiment 1”, and in
the results of Dennis and Schmidt (2003), responses in
RCM although slower than those in RCC are faster than
in the unprimed control condition. The associative account
of the outcome congruence effect claims that conclusions
about relative size become associated with words on prim-
ing trials and are retrieved on test trials. In RCMC the
retrieved conclusions will be incorrect and will need to be
suppressed in order to produce the correct response. The
error rates fit well with this account; participants in Experi-
tment 1 made more errors in the RCMC condition than in
the unprimed condition. However, the finding that RCMC
produces faster responses than the unprimed control chal-
genues a purely associative account.

One way of trying to account for the absence of latency
inhibition in RCMC might be to suggest that participants
adopt a different speed-error compromise in primed condi-
tions. A rapid familiarity check could lead people to
respond more quickly in conditions containing primed
words but at the cost of greater errors. However, although
this account might explain the absence of latency inhibition
on RCMC, it is rendered less plausible by the low error
rate in RCC.

A more likely explanation is suggested by the elabora-
tion of the associative account of priming presented by Sch-
acter, Dobbins and Schnyer (2004) who argue that it is a
representation of the stimulus at a lexical level which
becomes associated with an outcome, so that the associative
mechanism enables the semantic level of analysis to be by-
passed. However, access to the relevant lexical representa-
tion still depends on earlier perceptual analysis and latency
facilitation in RCMC may be attributed to tuning of these
earlier perceptual processes. Several arguments lend
credence to this possibility. First, as argued above, if associa-
tions are task-specific then the cross-task priming found in
“Experiment 2” and many other studies must be explained
by some other mechanism. Second, whilst the amnesic par-
ticipants studied by Schnyer et al. (2006) failed to show any
benefit of multiple repetitions and or any difference
between same-task and cross-task priming they still showed
an amount of priming equal to the cross-task priming seen
in controls. This indicates that while the mechanisms of
associative priming are impaired in this amnesic group
there are other components of priming which are spared.
Third, Waszak and Hommel (2007) observed that depend-
ging on a variety of factors, cross-task priming can either facilitate or delay responding, with the latter occurring pri-
marily in situations in which participants repeatedly
switched between tasks during the test block. They interpret
their results as showing that cross-task priming has both an
associative and a perceptual component with the former
leading to delayed responses and the latter to facilitation.

This two component view of priming explains the
absence of latency inhibition in RCMM by claiming that it
is over-ridden by facilitation from the perceptual compo-
nent of priming. In addition to providing a further test of
the task-specificity of the outcome congruence effect.
“Experiment 3” sought to test this two component expla-
nation. As in “Experiment 2” there were both same-task and
cross-task conditions. However, in “Experiment 3”, words
were re-paired between priming and test to create the RCC
and RCMM conditions. The preceding arguments lead to a
number of predictions about the results of this study. If
associative retrieval does not occur when the priming and
test task differ then there should be no outcome congruence
effect in this situation. However, perceptual, and other non-
associative components of priming will still be present in
the cross-task situation. Hence the comparison of same-task
and cross-task priming will isolate the effect of the associa-
tive component of priming. In a same-task RCC condition
retrieved responses will be appropriate and should thus pro-
duce additional facilitation relative to the cross task situa-
tion. However, in a same-task RCMM condition retrieved
responses will be inappropriate and should thus produce
inhibition relative to the cross-task condition.

These predictions were tested in “Experiment 3” using
the standard size comparison task, in which participants
are required to decide which object is larger (WiL task), as the
test task and as the priming task for the same-task condi-
tion. An inverted size comparison task in which partici-
pants decided which is smaller (WiS task) was used as the
alternative priming task. Participants undertook two blocks
of priming trials, one on each task, followed by a block of
test trials. Stimuli were re-paired between the priming and
test trials in order to create test trials in the RCC and

### Table 5 Specimen stimuli illustrating the conditions of “Experiment 3”

<table>
<thead>
<tr>
<th>Priming task: “Which is larger?” (within-task)</th>
<th>Re-pair conclusion</th>
<th>Re-pair conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priming pairs Orange satchel Orange proton</td>
<td>Orange satchel</td>
<td>Orange proton</td>
</tr>
<tr>
<td>Turkey cow</td>
<td>Field cow</td>
<td>Field cow</td>
</tr>
<tr>
<td>Test pair</td>
<td>Orange cow</td>
<td>Orange cow</td>
</tr>
<tr>
<td>Priming Task: “Which is smaller?” (cross-Task)</td>
<td>Orange satchel</td>
<td>Orange satchel</td>
</tr>
<tr>
<td>Priming pairs Orange proton Field cow</td>
<td>Orange satchel</td>
<td>Orange satchel</td>
</tr>
<tr>
<td>Test pair</td>
<td>Orange cow</td>
<td>Orange cow</td>
</tr>
</tbody>
</table>

The test task was always the “Which is Larger?” task. The item constituting the correct response is underlined.

#### Participants

The participants were adults from the University of Plym-
outh participation pool who took part in return for a course
credit or cash payment. Ten participants were replaced—
six because their mean response time was greater than two
standard deviations above the group mean and a further
four who had over 25% errors on one or more of the three
blocks. A further participant was randomly discarded to
maintain counterbalancing. The data reported are based on
the remaining 80 participants.

#### Design

There were two priming blocks and a test block. In one of
the priming blocks and in the test block participants
decided which of the two words that appeared on screen
referred to the larger object. In the other priming block the
participant determined which of the two objects was typi-
cally smaller. For half the participants priming with the
WiS task preceded priming with the WiL task whilst for the
other half of the participants this order was reversed.

Critical pairs in the test block appeared in one of the four
conditions created by the factorial combination of the two
re-pair conditions (RCC and RCMM) with the two priming
tasks (WiS and WiL) in which the words forming the test
pair could have appeared. The test block, which was identical
for all participants, consisted of 24 trials in each of these
ten conditions along with an additional 24 unprimed pairs
tested in random order. In order to counterbalance for possible
differences between stimuli sets of 24 critical pairs were
tested through the different conditions across participants.
For half of the critical pairs the two words appeared in the
same position that they had on the priming trial, for the
other half of the pairs the two words were switched. Half of
the critical pairs required a left hand response and half a
right hand response. Critical word pairs were generated
using sets of six objects ordered in size in the same way as for “Experiment 1”.

1012 Procedure

1013 General procedural details were the same as for previous
experiments. Participants were told that there were three
blocks of trials, and in each block they would make a different
judgement. In one priming block and in the test block
participants were asked to respond with the key on the same
side as the larger object. In the other priming block participants were asked to respond with the key on the same side
as the smaller object. The sequence of events on each trial
do not deviate from the presentation were the same as for the previous studies.

1023 Each block started with 15 practice trials, for the two
priming blocks these were followed by 96 priming trials
and for the test block they were followed by 120 test trials.

1026 Each block was preceded by instructions appropriate to the
task on that block.

1028 Results

1029 Data were processed in the same fashion as for “Experiment 1”. In this study 0.10% of trials had latencies below
400 ms and were therefore discarded as anticipations.

1032 Table 6 shows mean latencies for correct responses and
error rates for test trials in the different conditions of “Experiment 3”. The key question to which this Experiment
addressed was whether the size of the outcome congruence
effect depended on the priming task. This task was
examined using an ANOVA with Priming Task (WiL vs. WiS) and Condition (RCC vs. RCMM) as repeated measures factor and order of the two priming tasks and counterbalancing group as between participant factors. For
latencies there was a main effect of Priming Task whereby
priming on the WiL task led to faster responses than priming
on the WiS task, F(1,70) = 7.76, MSE = 3,462, P = 0.007, although error rates showed no main effect of
task, F(1,70) = 0.024, MSE = 12.3, P = 0.88. There was no
main effect of Condition on response latencies, F(1,70) = 0.10, MSE = 2,344, P = 0.75, but the overall
erate error was higher in the RCMM condition than in the
RCC condition F(1,70) = 4.7, MSE = 16.8, P = 0.033.

More importantly there was a significant interaction between Priming Task and Condition on both latencies,
F(1,70) = 5.12, MSE = 1,906, P = 0.027, and errors,
F(1,70) = 8.48, MSE = 15.2, P = 0.005. Tests of simple main effects showed that in the cross-task condition there was no significant difference between RCC and RCMM for either latencies, F(1,70) = 1.51, MSE = 2,309, P = 0.22, or errors, F(1,70) = 0.18, MSE = 16.6, P = 0.67. In the same-task condition the difference between RCC and RCMM fell slightly short of significance for latencies, F(1,70) = 3.35, MSE = 1,942, P = 0.072, although it was significant for errors F(1,70) = 13.3, MSE = 15.4, P = 0.001. There was no evidence of any effects of the order in which the two priming tasks were presented.

Discussion

The first aim of “Experiment 3” was to confirm the conclusion derived from Experiments 1 and 2 that congruence between the decision at test and the decision during priming affects performance when the test and priming tasks are the same but not when they differ. If so there should be an interaction between priming task and condition such that RCC shows more priming than RCMM in the same-task case but they do not differ in the cross-task case. To a large extent this prediction was confirmed. On both latencies and errors there was a significant task by condition interaction and neither measure showed any difference between RCC and RCMM in the cross-task case. In the same-task case the error effect remained unambiguous, although the latency effect was substantially weaker than in “Experiment 1” and the relevant simple main effect fell slightly short of significance. Any account of why the outcome congruence effect was weaker than in “Experiment 1” is necessarily speculative. The most obvious difference between the two studies is that participants in “Experiment 3” are tested following exposure to the inverted task and that items primed on the two tasks are mixed in the test block. It is notable that...
Schnyer et al. (2006) found that the benefit of additional priming trials was no longer apparent when a block of trials on the inverted task intervened between priming and test. The second purpose of “Experiment 3” was to use the cross-task condition as a control for non-associative components of priming and to determine whether the same-task RCMM condition would show inhibition relative to the control. As far as latencies are concerned there was no indication of inhibition, the same-task RCMM condition was in fact non-significantly faster than both of the two cross-task conditions. However, there was a significant main effect of priming task on error rate whereby same-task RCMM produced more errors than cross-task RCMM. Thus using cross-task priming as a control does not change the outcome from that which was observed with an unprimed control in “Experiment 1”. Both experiments show dissociation between latency effects and error effects, with inflated error rates occurring in RCMM despite the absence of latency inhibition. Unlike in “Experiment 1” the absence of latency inhibition in “Experiment 3” cannot be due to it being outweighed by non-associative priming. The introduction to this experiment suggested a two component account of priming to explain the pattern of results seen in “Experiment 1” and in Dennis and Schmidt (2003). The continued absence of latency inhibition in “Experiment 3” casts doubt on this proposal. An alternative way in which the associative account can be elaborated to cope with the results of “Experiment 3” is considered in the “General discussion”.

General discussion

The primary aim of the experiments reported in this paper was to ask whether the properties of the outcome congruence effect are compatible with existing evidence on the characteristics of the associative mechanism in three respects—the obligatory encoding and retrieval of associations, the nature of the response that is associated with a stimulus and the task-specificity of associations. In each of these three regards the results indicate that an associative account of the outcome congruence effect leads to conclusions which are concordant with those from other paradigms.

In line with other evidence indicating the encoding and retrieval of associations is obligatory rather than strategic, “Experiment 1” showed that changing the context, so that there is no overall benefit in retrieving previous responses, does not modify the outcome congruence effect. It also showed that the effect depends not on congruence of motor responses but on congruence of task-based decisions. This latter result is again concordant with other evidence as discussed above. Experiments 2 and 3 investigated task specificity of the outcome congruence effect by incorporating conditions in which the priming and test task differed. In both studies the cross-task condition showed no effect of whether or not the responses required by the two tasks matched. In terms of the associative account this indicates that activation of stimulus–response associations at test is dependent on having the same task context. This interpretation is reinforced by the finding in “Experiment 2” that same-task priming exceeds cross-task priming even when both have the same perceptual requirements and involve the same aspect of semantic knowledge. If response retrieval accounts for a significant component of priming and only occurs when the test and priming tasks are the same then same-task priming must exceed cross task priming. The conclusion that the associative mechanism only contributes to priming when the same task is used in the test and priming phases is consistent with other evidence from repetition priming studies where a single task is used over many trials (Dobbins et al., 2004; Schnyer et al., 2006; Schnyer et al., 2007; Zeelenberg et al., 2004).

For the most part the results of these studies help to support an associative account of the outcome congruence effect by showing that it leads to a view of the associative process which is compatible with that emerging from other lines of evidence. However, one feature of the data does not accord well with a simple associative account. “Experiment 3” used cross-task priming, from inverted size comparison to standard size comparison, to control for non-associative components of priming. The standard associative account predicts that the same-task RCC condition will show inhibition relative to this cross-task control but this did not occur. Hence, whilst the difference between RCMM and RCC demonstrates that decisions about relative size form part of what becomes associated with a word stimulus, the absence of latency inhibition in RCMM, even relative to a cross-task control, suggests that this is not the whole story.

A variant of the associative account that more successfully explains the full pattern of results is that adopted by Rothermund et al. (2005). In discussing the nature of the response that becomes associated with a stimulus they conclude that “…all kinds of processes that are elicited in an organism by a certain stimulus situation can be classified as a response, including perceptual processing, semantic representation and overt reactions” (p. 493). An alternative way of expressing this might be to say that outcomes of analysis at a variety of levels become associated with a stimulus and are retrieved when the stimulus recurs. This view retains the general associative principle of Instance Theory along with the assumptions of obligatory encoding and retrieval but differs in terms of what is retrieved and how this contributes to determining a response. As far as the former is concerned what is retrieved is no longer
simply a task-related decision but outcomes from a number of levels that have contributed to that decision. In relation to determining the response, Instance Theory argues that retrieval of a previous decision races against a re-determination of the decision through repeating procedures by which it was initially established. These two processes are independent and the response made and the time taken to make it are wholly determined by the winning process. This horse race aspect of Instance Theory is not easy to integrate with the notion of retrieving previous results from a variety of levels of processing. An alternative to the race account which is more compatible with multi-level retrieval is that re-computation and retrieval interact through the summation of evidence deriving from the two processes.

What happens then when a word is re-presented as part of an RCMM pair on a test trial? A variety of results deriving from the priming trial in which the word appeared will become available. Some of these outcomes, such as information relating to the absolute size of the object in question will be helpful in responding to the word despite the fact that it occurs with a new partner, and the rapid availability of results of this type may contribute to latency facilitation. However, other products of processing on the priming trial, in particular those relating to the object’s relative size, will no longer be valid. In so far as these latter outcomes influence processing on the test trial, they may lead to incorrect responses or set up a conflict whose resolution delays the response.

Under this view the latency facilitation shown by the RCMM condition relative to both the unpinned control in “Experiment 1” and the cross-task control in “Experiment 3” may be attributed to the associative retrieval of the products of pre-decision analysis. Such retrieval does not occur in either control condition—in the unpinned case there is nothing to retrieve and we have argued above that there is no retrieval in the cross-task case. At the level of pre-decision analysis evidence derived through retrieval summates with the results of new analysis and produces latency facilitation which apparently outweighs any delays arising from decision conflict. On the other hand, there may be some RCMM trials on which the conflict between analysis-driven responses and those driven by associatively retrieved conclusions is incorrectly resolved in favour of the latter, leading to an excess of errors in the RCMM condition.

The relationship of the account just discussed to that provided by the principle of TAP warrants comment. As generally stated TAP is the principle that facilitation increases as the degree of overlap between mental processes at test and those during priming increases. However, the principle itself needs explanation and two quite different explanations are possible. The explanation favoured by at least some proponents of TAP (e.g. Masson & Macleod, 1997), is that processes which have previously occurred thereby become more fluent. However an alternative possibility, drawing on the ideas presented above, is that retrieving the products of processes that occurred previously will reduce the amount of processing required on test trials and thus facilitate performance. The outcome congruence effect is more easily reconciled with the second explanation of TAP since it depends on process outcomes rather than on the processes themselves. What differentiates RCC from RCMM is not the process of comparison; both conditions require a comparison that has not previously been made, but rather the relationship of the outcome of that comparison to previous outcomes. The other way in which the current account differs, at least in emphasis, from many expositions of TAP is in the importance of context and especially task context. If repetition of a process invariably facilitates that process then facilitation will not be moderated by context. In contrast, retrieval of the products of processing may depend on whether the context at test, including the task set, matches that at the time of learning.

Acknowledgments The studies reported in this paper were supported by the Economic and Social Research Research Council through award RES-000-22-1191 which is gratefully acknowledged.

References


