Research Article

Position Coding in Two-Digit Arabic Numbers

Evidence From Number Decision and Same-Different Tasks

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Abstract. Digit position coding in two-digit Arabic numbers was examined in two masked priming experiments. In Experiment 1, participants had to decide whether the presented stimulus was a two-digit Arabic number (e.g., 67) or not (e.g., G7). Target stimuli could be preceded by a prime which (i) shared one digit in the initial position (e.g., 13-18), (ii) shared one digit but in a different position (83-18), and (iii) was a transposed number (81-18). Two unrelated control conditions, equalized in terms of the distance between primes and targets with the experimental conditions, were also included (e.g., 79-18). Results showed a priming effect only when prime and target shared digits in the same position. Experiment 2 employed a masked priming same-different matching task – a task that has been successfully employed in the literature on letter position coding. Results showed faster response times when prime and target shared digits – including the transposed-digit condition – relative to the control conditions. Thus, the identity of each digit in the early stages of visual processing is not associated with a specific position in two-digit Arabic numbers. We examine the implication of these findings for models of Arabic number processing.

Keywords: Arabic number recognition, digit position coding, same-different task, number decision task

In order to recognize an Arabic number, readers have to accurately process not only the identity but also the position of a number's constituent digits. If not, Arabic numbers like 1942 and 1492, or 18 and 81, would not be distinguished. Despite the obvious relevance of position coding in Arabic number processing, these perceptual processes have not been thoroughly investigated, and models of Arabic number recognition remain silent regarding this process (e.g., see Cipolotti & Butterworth, 1995; Dehaene & Cohen, 1995; McCloskey, 1992).

The present research examines how digit position coding is attained in two-digit Arabic numbers as they seem to constitute a special category within multidigit numbers. Leaving aside that two-digit numbers are much more frequent than other multidigit numbers, numbers with three or more digits seem to require a decomposition (parsing) process (e.g., Brysbaert, 2005). In contrast, it is still under debate whether two-digit numbers are processed compositionally (i.e., each digit pair being processed separately as a decade digit and a unit digit) (see McCloskey, 1992; Ratinckx, Brysbaert, & Fias, 2005), holistically (i.e., each digit pair being processed as one number) (e.g., Brysbaert, 1995; Dehaene, Bossini, & Giraux, 1993; Reynvoet & Brysbaert, 1999; Zhang & Wang, 2005), or both (Moeller, Nuerk, & Willmes, 2009; Nuerk, Weger, & Willmes, 2001).

The literature on digit position coding using two-digit Arabic numbers is very scarce. Only Ratinckx et al. (2005) provided some indirect evidence regarding how digit position is encoded within a digit string. Using a masked priming paradigm in a naming task, they found a facilitatory priming effect for targets sharing a digit in the same position with the prime (e.g., both 13 and 28 facilitated the processing of 18 relative to the control prime 23). In addition, Ratinckx et al. found an inhibitory priming effect when prime and target shared one digit at noncorresponding places (e.g., 83-18 vs. 92-18) and when prime and target shared two digits at noncorresponding places (e.g., 81-18 vs. 79-18). However, they failed to find any priming effects in a number decision task ("is the presented stimuli a number or a number-letter combination?") and in a task in which participants had to decide whether the digits were presented in *italics* or not (Ratinckx et al., 2005; Experiments 4 and 5). Ratinckx et al. concluded that the obtained priming effects in the naming task were probably due to language production processes.

The potential problem here is that one might argue that 13, 81, and 83 have a higher degree of perceptual similarity with 18 than an unrelated number like 79, and this should facilitate its recognition. Indeed, in the literature on visual-word recognition, a transposed-letter stimulus (e.g., *jugde*) is perceptually more similar to its base word (*judge*) than an orthographic control (i.e., a replaced-letter item such as *jupte*) (see O'Connor & Forster, 1981; Perea, Rosa, & Gómez, 2005). Likewise, a target word is recognized faster

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when it is preceded by a briefly presented transposed-letter nonword prime (*jugde-JUDGE*) than when it is preceded by an orthographic control (*jupte-JUDGE*) (see Perea & Lupker, 2003a, 2003b). The basic conclusion from these studies is that letter position takes long to encode. Importantly, there is a recently proposed orthographic coding scheme that can also be applied to the earliest stages of digit processing: the overlap model (Gomez, Ratcliff, & Perea, 2008). This model assumes that locations of well-known objects (e.g., letters) are best understood as distributions along a dimension – position in the string – rather than as precise points, and this is shared with more general models of attention (e.g., the CODE model; see Logan, 1996). More specifically, the overlap model considers that the representation of a letter (or an object) is normally distributed across ordinal positions in the letter string. But the relevant point here is that, in all these cases, the position assignment process in the overlap model is based on a general assumption of position uncertainty among a series of familiar objects (see also Norris, Kinoshita, & Van Casteren, 2010, for a Bayesian model using the idea of perceptual uncertainty). Thus, the overlap model predicts digit transposition effects when reading numbers. Given that the conclusions in the Ratinckx et al. (2005) paper seem to be at odds with the literature on letter position coding, it is important to re-examine how digit position is attained in two-letter Arabic numbers.

Indeed, a recent study conducted by García-Orza, Perea, and Muñoz (in press), using four-item length strings, demonstrated that transposition priming effects are not specific to letter strings, but they also occurred for digit strings and symbol strings in a masked priming same-different matching task. In these experiments, transposed stimuli facilitated the processing of their base stimuli nearly as much as identity primes and substantially more than substitution primes or unrelated primes. Participants in a same-different task are required to press the "same" button if the probe and target are the "same" and to press the "different" button if the probe and target are "different." Kinoshita and Norris (2009) adapted the task for masked priming by putting a masked prime before the target (see also Kinoshita, Castles, & Davis, 2009; Perea & Acha, 2009; Perea, Duñabeitia, Pollatsek, & Carreiras, 2009, for extensive use of this task). What we should note here is that the stimuli employed by García-Orza et al. (in press; Experiment 3) were four-digit numbers. It is unclear whether the findings reported by García-Orza et al. can be extended to two-digit numbers. As indicated earlier, two-digit numbers have a special status in the literature on number processing. Furthermore, in the literature on letter position coding, the size of transposed-letter priming tends to decrease: (i) for shorter words (Acha & Perea, 2008; Schoonbaert & Grainger, 2004), (ii) when the external letters – especially the initial letter – are involved (e.g., Gomez et al., 2008; Perea & Lupker, 2007), and (iii) when the transposed letters are situated close to the fixation point (Van der Haegen, Brysbaert, & Davis, 2009).

In the present study, we conducted two masked priming experiments to explore digit position coding in two-digit Arabic numerals. In Experiment 1, we employed a number decision task analogous to that used by Ratinckx et al. (2005). In Experiment 2, we employed a task which has proven to be highly sensitive to position coding in the literature on word processing: the same-different matching task. As no genuine neutral condition (e.g., two hashmarks as a prime) was included either in Ratinckx et al. (2005) or in this study, the terms "facilitation" and "inhibition" are not strictly speaking justified; thus, these terms should be understood as referring to a "better" and "worse" performance compared to an unrelated two-digit Arabic number.

Experiment 1

Method

Participants

Thirty-four students from the University of Málaga (range: 18–27 years old and mean = 19 years) took part in the experiment in exchange for course credit. All were native speakers of Spanish and none of them reported specific problems in mathematics.

Materials

Based on the stimuli employed by Ratinckx et al. (2005), a set of 41 two-digit Arabic numerals were selected as targets. These targets were preceded by primes selected according to three conditions: (1) primes that share the first digit, the decade (i.e., the "tens"), with the target (e.g., 13-18), (2) primes that were formed by transposing the two digits in the number (e.g., 81-18), and (3) primes that shared one of the digits, the decade, with the target but in a different position, the units (e.g., 83-18). Two more conditions were built using primes unrelated to the targets to be employed as control conditions. In one of the control conditions the mean distance between primes and targets was the same as the mean distance between primes and targets in the decade-overlap condition ($M = 5.07$ in both cases). In the other control condition, the mean distance between primes and targets ($M = 36.53$) did not differ from the mean distance in the transposed condition ($M = 36.43$) and in the decade-to-unit condition ($M = 37.34$), respectively, $t(40) = 0.5$, $p = .9$ and $t(40) = 0.4$, $p = .6$. Keep in mind that the distance effect (i.e., the bigger the distance between two numbers, the easier to discriminate between them) seems to affect many numerical tasks like number comparison (e.g., Moyer & Landauer, 1967).

The stimuli for "no" responses were the same targets except that one of the digits (a decade on half of the trials and a unit on the other half) was replaced by an uppercase letter that, when possible, had certain visual similarity with the replaced number. This was done to increase the difficulty of the task. The letters were: S, I, Z, G, and A. The primes for "no" responses were two-digit numbers different from those employed for the "yes" responses and had no relationship with their corresponding targets.

Table 1. Mean response times (in ms), percentage of errors, and mean priming effects as a function of the different priming conditions in Experiments 1 and 2 (*SD* in parentheses)

	Decade overlap 13-18	Control 23-18	Transposition 81-18	Control 92-18	Decade-to-unit 83-18	Control 92-18
Experiment 1: Number decision task						
Response times	480 (45.3)	487 (47.0)	489 (50.0)	488 (43.9)	485 (46.8)	488 (43.9)
Priming effect	7*		−1		3	
Percentage of errors	3.2 (2.8)	2.8 (3.4)	3.0 (3.4)	3.6 (3.6)	2.8 (2.5)	3.6 (3.6)
Priming effect	−0.4		0.6		0.8	
Experiment 2: Same-different task: same responses						
Response times	471 (79.2)	503 (69.1)	465 (69.8)	510 (70.7)	490 (70.8)	510 (70.7)
Priming effect	32**		44**		19**	
Percentage of errors	3.5 (4.6)	6.7 (6.0)	2.1 (2.8)	7.0 (5.2)	4.4 (4.9)	7.0 (5.2)
Priming effect	3.2*		4.8**		2.6	

Note. Control condition for transposition and decade-to-unit condition was the same. *$p < .05$; **$p < .01$.

A total of 410 (41 Targets × 5 Prime types × 2 Responses) trials were presented. Half of the trials were prime-target pairs of two-digit Arabic numbers. The other half were trials in which the targets were composed of one digit and one letter.

Procedure

Participants were tested in groups of up to five people. Stimuli were presented synchronized with the refresh cycle (16.6 ms) of a 16-in. color screen in white on a black background using PCs running the ERTS software for MS-DOS (Beringer, 1999). Reaction times (RTs) were measured from target onset until the participant's response. On each trial, a forward mask consisting of four hash marks (####) was presented for 250 ms. Next, the forward mask was replaced by a prime presented for 33 ms, which was replaced by a backward mask for 17 ms, later in the same position of the mask appeared the target. The target stimulus remained on the screen until the response or during 2,500 ms. Participants were told that they have to press the button marked "SÍ" [YES] if they were presented with two-digit Arabic numbers and the button marked "NO" if they were presented with a different stimulus. Participants were instructed to make this decision as quickly and as accurately as possible. Participants were not informed of the presence of prime stimuli. To avoid physical continuity between primes and targets, primes were presented in Courier font with different size: 14 and 18 pt, respectively. The experiment started with 16 training trials randomly chosen from the 410 experimental trials. Each participant received a different, randomized order of trials. The experiment lasted ~ 10 min.

Results and Discussion

Two participants were eliminated from the analyses, one for having more than 25% of errors and another for having extremely slow response times (more than 15% of the response times were higher than 1,000 ms). Incorrect responses (3.1% of the trials) and response times < 250 or > 1,000 ms (< 0.6% of the trials) were excluded from the latency analysis. The mean response times and error percentages from the participant analysis are presented in Table 1. Given that there was no relationship between primes and targets in "no" responses (i.e., they were composed of a letter and a number), only response times and accuracy in "yes" responses were analyzed.

Planned comparisons over the critical contrasts (i.e., decade overlap, transposition, and decade-to-unit vs. their corresponding controls) were conducted for participants and items. On average, response times to targets were faster when the digit in the decade matched the decade in the prime than for the targets preceded by a control prime (480 vs. 487 ms, respectively), $t1(31) = 2.17$, $p < .05$, $t2(40) = 2.01$, $p < .06$. The other two contrasts did not approach significance: targets preceded by a transposed prime were not faster than targets preceded by its control prime (489 vs. 488 ms), $t1(31) = 0.17$, $p > .20$, $t2(40) = 0.21$, $p > .83$, and similarly, no differences were found between the decade-to-unit condition and its control (485 vs. 488 ms), $t(31) = 0.97$, $p > .20$, $t2(40) = 0.89$, $p > .37$.

The analyses on the error data did not show significant differences in any comparison (all *p*s > .25).

This experiment was intended to replicate Ratinckx et al.'s (2005) Experiment 4. The results were clear. We found a small (7 ms) but significant priming effect when prime and target shared one digit on the same position (13-18), but not when they shared one digit in different positions (e.g., 81-18 or 83-18). These results contrast with the absence of significant effects in Ratinckx et al.'s Experiment 4; nonetheless, the size of the priming effect in the decade-overlap condition in their experiment was a nonsignificant 4-ms trend – which is in the same direction as the obtained effect here. The reasons for this small discrepancy are not clear. There were some minor differences across experiments. First, the targets here were presented five times, while in the Ratinckx et al. study, targets were presented ten times. Second, and more importantly, we employed 41 targets instead of 47; the reason is that, as pointed out by Ratinckx et al. (see Table 1), six of the control primes in the decade-overlap condition were related to the targets by sharing the digit in the decade with the digit in the unit (e.g., 17-21). Although this condition, decade-to-unit, had no significant effect in our experiment, it was 3 ms faster than the control condition. In other words, it might be that these related control primes diminished slightly the decade-overlap priming effect in the Ratinckx's et al. (2005) experiment.

At first glance, one might think that our finding supports the view that digit identities are associated with a specific position within the number. However, one must be cautious about this null effect. The lack of priming effects in the number decision task may be due to the particularities of the task. In this task, letters are used to form the "no" response, hence it is difficult to assess whether participants are responding to numbers' identity or to another kind of highly familiar stimuli (i.e., letters). The use of this strategy may diminish the size of priming effects (see General Discussion for further discussion).

Thus, it is critical to re-examine the presence of digit position priming with two-digit Arabic numbers using a more powerful task. Here we chose a masked priming same-different task because this task taps the early stages of visual processing and is highly sensitive to (letter) position coding (see Norris & Kinoshita, 2008).

Experiment 2

The materials from Experiment 1 were adapted to the same-different matching task. According to Ratinckx et al. (2005), masked priming effects with two-digit numbers are due to the involvement of language processes. If this view is correct, when no verbal processes are involved – as is the case in the same-different task (see Norris & Kinoshita, 2008), no priming effects would be expected. Alternatively, if digit position coding at the early stages of processing is noisy (e.g., in the basis of perceptual uncertainty), one would expect a facilitative effect of sharing digits in the same or different position. We must bear in mind that the same-different task provides highly valuable data on letter position coding (Kinoshita & Norris, 2009; see also García-Orza et al., in press; Perea & Acha, 2009; Perea et al., 2009). Even with two-letter words, Kinoshita and Norris (2008) found a significant transposed-letter priming effect (around 60 ms) with this task (e.g., ON-NO).

Method

Participants

Sixteen graduate and undergraduate students from the University of Málaga (range: 18–28 years old and mean = 22 years) took part in the experiment voluntarily. All were native speakers of Spanish and none of them reported specific problems in mathematics.

Materials

For the same-different task, the 41 two-digit Arabic numbers employed as targets in Experiment 1 were also used as probes and targets in the same pairs, that is, they were probes and targets in the same trial. Another set of 41 two-digit numbers were selected as targets to create different probe-target pairs. A total of 410 trials (41 Targets × 5 Prime types × 2 Responses) were presented. On half of the trials the probe and the target were the same and on the other half of trials, the probe and the targets were different. In the same condition all targets were preceded by its corresponding same probe and one of the five different types of primes, decade overlap, transposition, decade-to-unit, and the two control conditions (e.g., for the target 18, the probe would be 18 and the prime could be 81). In the different condition all targets were preceded by its corresponding different probe, but in this occasion the five different types of primes were related to the probes and were totally different from the targets (e.g., for the target 52, the probe would be 18, and the prime could be 81). This way, participants could not anticipate any (implicit) responses on the basis of the relationship between the probe and the prime (i.e., a zero contingency scenario; see Perea & Acha, 2009).[1]

Procedure

Participants were tested in groups of up to five people. Stimuli were presented synchronized with the refresh cycle (16.6 ms) of a 16-in. color screen in white on a black background using PCs running the ERTS software for MS-DOS (Beringer, 1999). RTs were measured from target onset until the participant's response. On each trial, a probe was presented above a forward mask consisting of four hash marks (####) for 1,000 ms. Next, the probe disappeared, and the forward mask was replaced by a prime presented for

[1] It may be important to note that we found the same pattern of data in an additional experiment in which the five different types of primes were related to the target, while the probe was unrelated to prime and target (e.g., for the target 18 the probe would be 52 and the transposed-letter prime would be 81). On average, responses for targets in this experiment were faster and more accurate when the digit in the decade matched the decade in the prime than for targets preceded by a control prime: 473 versus 502 ms, $t1(22) = 5.42$, $p < .001$, $t2(40) = 5.62$, $p < .001$, 3.5 versus 6.9% of errors, $t1(22) = 2.96$, $p < .01$, $t2(40) = 4.04$, $p < .001$. Responses to targets were also faster and more accurate when preceded by a transposed prime than when preceded by a control prime: 475 versus 502 ms, $t1(22) = 5.19$, $p < .001$, $t2(40) = 4.27$, $p < .001$, 3.3 versus 5.5% of errors, $t1(22) = 2.57$, $p < .05$, $t2(40) = 2.16$, $p < .05$. Furthermore, targets preceded by a prime that shared one of the digits with the target were responded to faster and more accurately than when preceded by a control prime: 488 versus 502 ms, $t1(22) = 3.26$, $p < .01$, $t2(40) = 2.45$, $p < .05$, 3.9 versus 5.5% of errors, $t1(22) = 2.13$, $p < .05$, $t2(40) = 1.72$, $p = .09$. Finally, the analyses on the RTs and on the error data in the "different responses" did not show any significant effects (all ps > 25).

50 ms, which was replaced by a target. The target stimulus remained on the screen until the response. Note that the masking procedure differs between both experiments – this was done to directly replicate Ratinckx's et al. and the standard same-different experiments (e.g., see Kinoshita & Norris, 2009); nonetheless, the interval between prime and target remained the same, 50 ms, in both cases. Participants were told that they would see strings of numbers, and that they were to press the button marked "SÍ" [YES] if they thought the probe and target were the same stimulus, and they were to press the button marked "NO" if they thought the probe and target was a different stimulus. Participants were instructed to make this decision as quickly and as accurately as possible. Participants were not informed of the presence of prime stimuli. Primes and targets were always presented in Courier font with different size: 14 and 18 mm, respectively. The experiment started with 16 training trials randomly chosen from the 410 experimental trials. Each participant received a different, randomized order of trials. The experiment lasted ~ 15 min.

Results and Discussion

One participant was eliminated from the analysis for having more than 29% of errors. Incorrect responses (3.4% of the trials) and response times < 250 or > 1,000 ms (< 2% of the trials) were excluded from the latency analysis. The mean response times and error percentages from the participant analysis are presented in Table 1. As usual with the same-different task (Norris & Kinoshita, 2008) we analyzed separately "same" and "different" responses.

"Same" Responses

The mean response times and error percentages from the participant analysis are presented in Table 1. As in Experiment 1, related conditions were compared to their corresponding control conditions. On average, responses for targets were faster when the digit in the decade matched the decade in the prime than for targets preceded by a control prime (471 vs. 503 ms), $t1(15) = 6.05$, $p < .001$, $t2(40) = 5.61$, $p < .001$. More important, responses to targets were faster when preceded by a transposed prime than when preceded by a control prime (465 vs. 510 ms), $t1(15) = 4.96$, $p < .001$, $t2(40) = 9.62$, $p < .001$. Finally, responses to targets were faster when preceded by a prime that shared one of the digits with the target than when preceded by a control prime (491 vs. 510 ms), $t1(15) = 3.03$, $p < .01$, $t2(40) = 3.76$, $p < .002$.

The analyses on the error data showed a similar pattern of effects. Planned comparisons showed again that the decade overlap between primes and targets facilitated the responses compared to the control condition (3.5% vs. 6.7% of errors), $t1(15) = 2.68$, $p < .02$, $t2(40) = 2.92$, $p < .007$. Transposed primes also facilitated the responses compared to the control condition (2.1% vs. 7% of errors), $t1(15) = 3.27$, $p < .006$, $t2(40) = 4.82$, $p < .001$. Finally, participants committed fewer errors when the target shared one digit with the prime but in different position than when the target was preceded by an unrelated prime (4.4% vs. 7% of errors), however, this difference was only significant by items, $t1(15) = 2.13$, $p > .05$, $t2(40) = 2.13$, $p < .04$.

"Different" Responses

The analyses on the RTs and on the error data did not show any significant effects (all $ps > .12$) with one exception restricted to the subject analysis: responses to targets were 13 ms slower when the probe and the prime shared the decade compared to a control prime (512 vs. 499 ms), $t1(15) = 2.31$, $p < .04$, $t2(40) = 1.55$, $p > .05$.

The results of Experiment 2 are straightforward. First, sharing one number in its correct position (e.g., 13-18 vs. 23-18) produces a facilitatory priming effect. Second, and more important, we found a significant effect of transposition priming with numbers (81-18 faster than 92-18) – this extends earlier research with four-digit Arabic numbers (García-Orza et al., in press). Third, sharing one digit, even in a different position, is enough to increase the speed and accuracy of the responses (i.e., faster responses to 83-18 than to 92-18). Thus, as in the literature on word processing, the masked priming same-different task has proven to be a highly sensitive tool to examine digit position coding.

General Discussion

The present masked priming experiments examined the processes involved in digit position coding with two-digit Arabic numbers. The main findings can be summarized as follows. First, Arabic numbers that share a digit in the decade position with the target (e.g., 13-18) facilitate its recognition compared to an unrelated control (e.g., 23-18) in both number decision and same-different tasks. Second, a robust priming effect was found in a same-different matching task for primes that shared digits in different positions with the target (e.g., transposition priming: 81-18 vs. 92-18 and decade-to-unit priming: 83-18 vs. 92-18), but not in a number decision task.

The weak priming effects in the number decision task probably reflect the fact that participants can perform this task without encoding the number identity per se but rather responding to the category "numbers" (i.e., if there is a combination of digits, press "yes") or even to the category "letters" (e.g., if any letter appears, press "no") (see Arguin & Bub, 1995; Kinoshita & Kaplan, 2008 for a similar argument regarding the absence of abstract letter identity priming effect in the alphabet decision task). These strategies might be also fueled by the fact that any combination of Arabic numbers constitutes a legal number. As both the related and the control primes provide the same information in terms of the task (i.e., a number is presented), they may facilitate almost to the same extent the decision about the target (see Norris & Kinoshita, 2008, for a similar argument when comparing lexical decision and same-different tasks). Thus, the number decision task may not be a sensitive tool to explore digit position coding.

Importantly, the presence of sizeable digit transposition priming effects and decade-to-unit priming effects in the same-different task strongly suggests that the position of each digit within the two-digit Arabic number is coded in a flexible way so that early in visual coding the identity of each digit is associated with different positions within a number. This finding is consistent with the idea of perceptual uncertainty in strings of familiar "objects" (e.g., letters and numbers) (Gomez et al., 2008; see also García-Orza et al., in press).

What are the implications of these findings for models of Arabic number processing? As indicated in the Introduction, these models do not specify in detail the stage of digit position coding (i.e., they remain silent regarding this process). The only model that has – to some degree – included some notions related to digit position coding is the model proposed by Nuerk et al. (2001) (see also Moeller et al., 2009; Nuerk & Willmes, 2005). In the framework of the processing of two-digit Arabic numbers, Nuerk and colleagues suggested that there would be number detectors for decade magnitude, unit magnitude and, eventually, overall magnitude. That is, the input of two-digit Arabic numbers would be organized into three representations: the decade, the unit, and the overall representation. Thus, this model assumes that digit position in two-digit numbers is coded very early in a fixed position – as in slot-coding schemes in visual-word recognition (e.g., McClelland & Rumelhart, 1981). Nonetheless, our data suggest that early in processing, digit position is coded in a noisy manner – as deduced by the data from Experiment 2. That is, regardless of how the magnitude representation of two-digit numbers is accessed, the processing of two-digit numbers involves an early process in which the identity of the digits occurs before the digits are assigned to their corresponding positions. Further research is needed to shed more light on how the alleged noisy position coding process may affect a process like magnitude comparison in which, according to Nuerk and Willmes (2005), a multiple comparison between digits is performed. Needless to say, future implementations of models of Arabic number recognition need to specify that position coding of digits within numbers is not accurate early in processing.

In sum, the present experiments shed some light on a neglected issue in the models of Arabic number recognition: how digit position is coded. The present findings are consistent with a coding scheme which allows some flexibility (or noise) in the assignment of objects to positions – even for two-digit numbers. Further research is needed to assess the specific contribution of digit overlap between primes and targets using other experimental tasks and numbers of varying length.

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