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Pairwise Go/No-Go Magnitude Comparison with Spatially Arranged Arabic Digits and Turkish Number Words

Şimal Yenigüllü
İzmir University of Economics
Ezgi Gür
İzmir University of Economics
Merve Bulut
Yaşar University
Hakan Çetinkaya
Yaşar University
Seda Dural
seda.dural@ieu.edu.tr

İzmir University of Economics

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Abstract

Pairwise magnitude comparison requires participants to evaluate the relative magnitude of two simultaneously presented numerical stimuli, and performance is commonly indexed by the numerical distance effect. Whether this relative-magnitude processing is accompanied by spatial compatibility for the conventional small-left/large-right arrangement remains less clear, especially when left–right response selection is minimized. The present study examined numerical distance effects and stimulus-arrangement compatibility in a pairwise go/no-go magnitude-comparison task. Across two experiments, participants viewed two numerical stimuli, one on the left and one on the right, and made a single central response only when the task-relevant number appeared in the instructed spatial position. Experiment 1 used Arabic digits, whereas Experiment 2 used Turkish number words. In both experiments, participants completed either a small-number or a large-number task. Robust numerical distance effects were observed in both experiments and task versions, indicating reliable access to relative numerical magnitude. In contrast, evidence for stimulus-arrangement compatibility was limited and task-dependent. This arrangement did not produce a general response-time advantage, and any compatibility-related patterns were limited to the small-number task. These findings suggest that pairwise go/no-go comparison reliably engages relative-magnitude processing without necessarily producing stable or general small-left/large-right compatibility. The results support a distinction between access to relative magnitude and the behavioral expression of arrangement-based spatial compatibility under specific task configurations.

Introduction

When people compare symbolic numbers, their responses are systematically shaped by the numerical relation between the values. A classic demonstration of this sensitivity is the numerical distance effect: responses are faster and more accurate as the numerical distance between two numbers increases (Moyer & Landauer, 1967). This effect is commonly taken to indicate that numerical magnitudes are represented along an ordered continuum, but it does not specify how, or whether, that continuum is directionally oriented in space. Evidence for directional spatial mapping comes from the Spatial–Numerical Association of Response Codes (SNARC) effect, in which responses are typically faster to smaller numbers with a left response and to larger numbers with a right response (Dehaene et al., 1993). This finding suggested that number processing can interact with left–right spatial codes even when numerical magnitude is irrelevant to the task. Subsequent work has broadened this phenomenon under the more general term spatial–numerical associations (SNAs), which refers to a family of behavioral and neural findings suggesting that numerical information is spatially represented (Cipora et al., 2018). Spatial–numerical effects have been reported across different tasks and stimulus formats, but their size and reliability appear to depend strongly on task structure and response coding (Bulut et al., 2026; Toomarian & Hubbard, 2018; Wood et al., 2008).

The present study approaches this issue from a different task context. Rather than examining a standard SNARC effect defined by left–right response mapping, it asks whether relative-magnitude processing is

accompanied by an arrangement-level benefit for numerical pairs presented in the conventional small-left/large-right configuration. Classical SNARC tasks, by contrast, typically assess SNAs by asking participants to classify a single centrally presented number using left and right responses. In parity judgment, participants classify numbers as odd or even, whereas in magnitude classification, they judge whether a number is smaller or larger than a reference number (Dehaene et al., 1993; Wood et al., 2008). In such tasks, compatibility is usually defined with respect to the mapping between number magnitude and spatial response codes: smaller numbers are compatible with left responses, whereas larger numbers are compatible with right responses. Although these tasks are highly informative, they can make it difficult to disentangle directional spatial coding from the selection of left–right response alternatives.

This response-coding issue is central to task-sensitive accounts of SNAs. Computational and working-memory accounts have proposed that spatial–numerical effects depend on how numerical, ordinal, spatial, and response codes are temporarily configured within the task (Gevers et al., 2006; van Dijck & Fias, 2011). Related empirical work is consistent with accounts in which directional spatial–numerical effects depend on task-defined integration of magnitude, space, and response codes, rather than solely on an invariant spatial response code triggered by number alone (Pinto et al., 2019, 2021; Shaki & Fischer, 2018). This perspective raises the possibility that access to numerical magnitude may not, by itself, produce an arrangement-level spatial-compatibility advantage when left–right response selection is minimized.

Pairwise magnitude comparison provides a useful context for examining this issue as participants compare two numerical stimuli within the same trial and decide which one is numerically smaller or larger. This type of comparative judgment is central to the numerical distance effect literature, because the effect is typically measured by asking participants to compare two numerical values within the same trial (Moyer & Landauer, 1967; Moyer & Bayer, 1976; Holloway & Ansari, 2009). However, standard pairwise comparison setups with spatially arranged number pairs often preserve a left–right response structure: participants typically respond according to the side of the selected item. Pairwise comparison studies with lateralized response alternatives have shown that spatial arrangement and response selection can influence numerical judgments, suggesting that response coding may play an important role in the behavioral expression of number–space mappings (Shaki et al., 2012; Patro & Shaki, 2016). Thus, pairwise comparison is well suited to testing relative magnitude processing, but standard versions often leave open how much of the spatial effect reflects the left–right response structure.

Go/no-go procedures provide a complementary approach by reducing the need to select between competing left and right responses. For example, Fischer and Shaki (2016) used centrally presented numbers and a single central response key to assess SNAs without physically lateralized stimuli or responses. More recently, Bulut et al. (2026) applied go/no-go procedures to parity judgment and magnitude classification tasks with lateralized single-number stimuli. They found a weak left-to-right SNA in go/no-go parity judgment, but no reliable group-level directional effect in go/no-go magnitude

classification. Together, these findings suggest that directional SNAs are shaped by the specific configuration of magnitude processing, stimulus position, and response requirements.

However, go/no-go magnitude classification still involves a single number on each trial. Pairwise magnitude comparison changes this structure because the relevant decision concerns the relation between two numerical stimuli presented within the same trial. In this context, compatibility can be defined at the level of the pair arrangement itself: a pair is compatible when the smaller number appears on the left and the larger number on the right, and incompatible when this arrangement is reversed. Thus, pairwise comparison allows arrangement-level spatial compatibility to be examined while participants directly compare two numerical values, rather than classify a single stimulus. This leaves open whether the conventional small-left/large-right arrangement facilitates performance when relative comparison is preserved but explicit left–right response selection is minimized.

A closely related paradigm was used by Pekár et al. (2023), who presented Arabic number pairs in a go/no-go numerical Stroop task and required participants to respond only when the numerically larger number appeared on the instructed side. This study provides an important methodological precedent by showing that simultaneous pairwise comparison can be implemented in a go/no-go format. However, because it focused on numerical Stroop interference rather than spatial–numerical compatibility, it does not directly address whether the conventional small-left/large-right arrangement facilitates relative-magnitude processing under single-response conditions.

Symbolic notation provides another way to evaluate the generality of this task pattern. Arabic digits and number words are both symbolic numerical formats, but they may differ in how numerical magnitude is accessed and how SNAs are expressed (Dehaene, 1992). Previous findings are mixed: some studies have reported comparable spatial–numerical effects across notations (Nuerk et al., 2005), whereas others have found notation-dependent differences, including effects for Arabic digits but not for number words in some tasks (Gong et al., 2019) and different spatial orientations for different notations in other tasks (Hung et al., 2008). Notation differences have also been observed in numerical comparison, with distance effects differing between Arabic digits and number words across languages, including Turkish (Cohen Kadosh et al., 2008; Lukas et al., 2014). Accordingly, the notation question in the present study is whether the same task yields a similar pattern across Arabic digits and Turkish number words.

The present study used a pairwise go/no-go magnitude-comparison task to examine spatial–numerical effects under a single-response format. On each trial, two numerical stimuli were presented simultaneously, one on the left and one on the right. Depending on the task version, participants responded only when the smaller or larger stimulus appeared in the instructed spatial position and withheld their response otherwise. This design allowed us to examine whether spatially arranged number pairs produced a numerical distance effect, and whether they also produced a compatibility effect favoring the small-left/large-right arrangement. Experiment 1 used Arabic digits, whereas Experiment 2 used Turkish number words. By combining pairwise magnitude comparison with a single-response go/no-go format, the study tested whether relative-magnitude processing would be

accompanied by arrangement-level compatibility, favoring the conventional small-left/large-right arrangement when explicit left–right response selection was omitted, and whether this pattern would be similar for Arabic digits and Turkish number words.

Experiment 1: Arabic Digits

In Experiment 1, participants completed a pairwise go/no-go magnitude-comparison task in which two Arabic digits were presented simultaneously, one on the left and one on the right. Depending on the assigned task version, participants responded only when the smaller or larger digit appeared in the instructed spatial position and withheld their response otherwise. The aim was to examine whether this task would elicit a numerical distance effect for Arabic digits and whether the conventional small-left/large-right arrangement would produce stimulus-arrangement compatibility.

Method

Participants

Sample size was determined a priori using G*Power 3.1 (Faul et al., 2007). Because the main analyses were conducted separately for the small-number and large-number tasks (see the Data Preparation and Analysis section for details), we determined the required sample size per task. The power analyses assumed α = .05, power = .85, and medium effect sizes, defined as Cohen's f = 0.25 for the ANOVA and Cohen's dz = 0.50 for the t-tests. The required sample size was 18 participants for the ANOVA and 31 participants for the t-tests. To allow for potential data loss, we aimed to recruit 35 participants per task. Accordingly, data were collected from 70 Turkish-speaking volunteers from Izmir University of Economics between May 2025 and November 2025. Participants received compensation for their participation and were randomly assigned to either the small-number task or the large-number task. All reported normal or corrected-to-normal vision and no history of spatial neglect, dyslexia, or dyscalculia. The recruited sample consisted of 54 women and 16 men, aged 18–40 years (M = 21.43, SD = 3.61). Based on the Edinburgh Handedness Inventory (Oldfield, 1971), 65 participants were right-handed, 4 were left-handed, and 1 was ambidextrous.

Stimuli and Apparatus

The experiment was programmed in SuperLab 6.4.3 (Cedrus Inc.) and administered on an HP ProOne 440 computer with a 23.8-inch monitor set to 1920 x 1080 pixels at 60 Hz. Participants were seated approximately 60 cm from the monitor. Go responses were collected via the space bar on a Turkish QWERTY keyboard. The stimulus pool comprised 72 spatially ordered pairs formed from the Arabic digits 1–9, with no repeated digit within a pair. On each trial, the two digits appeared simultaneously, 6° to the left and right of screen center, in black 55-point Courier New font on a gray background (RGB: 219, 219, 219). Numerical distance was defined as the absolute difference between the two digits and ranged from 1 to 8. Trials were classified as compatible when the smaller digit appeared on the left and the larger digit on the right, and as incompatible when this arrangement was reversed.

Procedure

To keep the experiment within a manageable duration, each participant received a balanced subset of 16 pairs selected from the full 72-pair stimulus pool. For each participant, this subset was selected randomly, with the constraint that it included one compatible and one incompatible pair at each numerical distance from 1 to 8. Thus, each participant received 8 compatible and 8 incompatible pairs.

Participants completed one of two go/no-go task versions, depending on their random assignment: the small-number task (N = 35) or the large-number task (N = 35). In both tasks, participants responded with the space bar using their dominant hand only when the task-relevant number appeared in the instructed spatial position and withheld their response otherwise. They were instructed to use the same response hand throughout the experiment. Each task consisted of two blocks, and block order was counterbalanced across participants. In the small-number task, participants pressed the space bar when the smaller number appeared on the left in one block and when the smaller number appeared on the right in the other block. In the large-number task, participants pressed the space bar when the larger number appeared on the right in one block and when the larger number appeared on the left in the other block. Thus, across blocks, both compatible and incompatible arrangements served as go trials.

Each trial began with a black central fixation square (9.4 x 9.4 mm) presented for 500 ms. The numerical pair was then displayed for 650 ms, followed by a 650-ms inter-trial interval. Responses were recorded within a 1000-ms window starting at stimulus onset, which included the 650-ms stimulus display and the first 350 ms of the inter-trial interval. Each block began with 16 practice trials, consisting of 8 compatible and 8 incompatible trials and covering all numerical distances. Accuracy feedback was provided only during practice to ensure that participants understood the instructions. In the experimental phase, the 16 selected pairs were presented 10 times each in random order, yielding 160 trials per block. Because each participant's stimulus subset contained equal numbers of compatible and incompatible pairs, and each block required responses to only one arrangement, half of the trials in each block were go trials and half were no-go trials. Across the two blocks, each participant completed 320 experimental trials in total.

Data Preparation and Analysis

Only experimental trials were included in the analyses. As the first step in data preparation, we checked whether each participant had correct go-trial RTs in every numerical distance x spatial compatibility cell needed to compute participant-level mean RTs. Two participants, one from each task, were excluded because one or more cells contained no correct go trials, preventing the computation of complete participant-level RT summaries. After these exclusions, 68 participants remained for analysis, with 34 participants in each task. Error rates were computed across all experimental trials. Incorrect responses accounted for 4.31% of trials, including 3.53% commission errors and 0.78% omission errors. RT analyses were restricted to correct go trials. Within correct go trials, RTs shorter than 150 ms or exceeding ±2.5 SD from each participant's mean RT were removed as outliers, excluding an additional 1.03% of trials. Overall, 94.66% of the data were retained for analysis.

Mean RTs for correct go trials were analyzed separately for the small-number and large-number tasks using 2 x 8 repeated ANOVAs with spatial compatibility (compatible vs. incompatible) and numerical distance (1–8) as within-subject factors. To quantify the numerical distance effect, we first computed an overall distance slope for each participant. Following Viarouge et al. (2014), mean RTs were computed for each numerical distance level (1–8) and regressed on numerical distance to obtain unstandardized slope coefficients; more negative slopes reflected faster responses as numerical distance increased and therefore a stronger distance effect. The resulting overall slopes were tested against zero using one-sample *t*-tests. To examine whether the distance effect differed as a function of spatial compatibility, the same slope-computation procedure was applied separately to compatible and incompatible trials, and the resulting distance slopes were compared using paired-samples *t*-tests.

Results

Descriptive statistics for mean RTs as a function of spatial compatibility and numerical distance for small-number and large-number tasks are presented in Supplementary Online Material (SOM) Table 1. Mauchly's tests indicated that the assumption of sphericity was violated for numerical distance and for the spatial compatibility x numerical distance interaction in both tasks; therefore, Greenhouse–Geisser-corrected degrees of freedom are reported for these effects. The main effect of spatial compatibility was not significant in either the small-number task, $F(1, 33) = 0.06$, $p = .813$, $\eta^2 = .002$, or the large-number task, $F(1, 33) = 0.17$, $p = .681$, $\eta^2 = .005$. The main effect of numerical distance was significant in both tasks, small-number task: $F(4.28, 141.16) = 20.50$, $p < .001$, $\eta^2 = .383$; large-number task: $F(4.19, 138.29) = 34.95$, $p < .001$, $\eta^2 = .514$. Linear polynomial contrasts showed significant linear trends in both tasks, small-number task: $F(1, 33) = 73.55$, $p < .001$, $\eta^2 = .690$; large-number task: $F(1, 33) = 146.56$, $p < .001$, $\eta^2 = .816$, indicating that RTs decreased as numerical distance increased. The spatial compatibility x numerical distance interaction was not significant in either task (see Figure 1), small-number task: $F(4.21, 138.80) = 1.28$, $p = .279$, $\eta^2 = .037$; large-number task: $F(4.06, 134.00) = 0.35$, $p = .848$, $\eta^2 = .010$.

Descriptive statistics for the overall distance slopes and compatibility-specific distance slopes in the small-number and large-number tasks are presented in SOM Table 2. The overall distance slope was significantly below zero in the small-number task, $t(33) = -8.27$, $p < .001$, Cohen's $dz = 1.42$, and in the large-number task, $t(33) = -12.00$, $p < .001$, Cohen's $dz = 2.05$, indicating a numerical distance effect in both tasks. Compatibility-specific slope comparisons showed that the distance slopes were more negative for compatible than incompatible trials in the small-number task, $t(33) = -2.69$, $p = .011$, Cohen's $dz = 0.46$. In contrast, this comparison was not significant in the large-number task, $t(33) = .11$, $p = .915$, Cohen's $dz = 0.02$.

Discussion

Experiment 1 showed robust numerical distance effects in both the small-number and large-number tasks, indicating that the pairwise go/no-go task elicited relative-magnitude processing for Arabic digits. The conventional small-left/large-right arrangement, however, did not produce an overall RT advantage, and the spatial compatibility x numerical distance interaction was not significant in either task. Thus, the

presence of a distance effect was not accompanied by a general stimulus-arrangement compatibility effect.

The only compatibility-related indication came from the slope-based analysis in the small-number task, which suggested a stronger numerical distance effect for compatible than incompatible arrangements. This pattern was not observed in the large-number task and was not supported by a significant interaction in the ANOVA. It should therefore be interpreted cautiously, as a task-specific indication that arrangement-level compatibility may be more visible when the task goal is aligned with the smaller magnitude pole.

In sum, Experiment 1 showed reliable distance-based magnitude effects for Arabic digits, but no general advantage for the conventional small-left/large-right arrangement; evidence for compatibility was limited to the slope-based pattern in the small-number task. Experiment 2 examined whether the same task pattern would emerge when the numerical pairs were presented as Turkish number words.

Experiment 2: Turkish Number Words

Experiment 2 extended the pairwise go/no-go task to written verbal notation by presenting the numerical pairs as Turkish number words rather than Arabic digits. This allowed us to examine whether the pattern observed with digits would also emerge for number words under the same task conditions. Because notation can affect both numerical comparison and the expression of SNAs, Experiment 2 tested whether Turkish number words would produce numerical distance effects and whether these effects would be accompanied by stimulus-arrangement compatibility, favoring the conventional small-left/large-right arrangement.

Method

Participants

Participant recruitment, compensation, eligibility criteria, and task assignment followed the same procedure as in Experiment 1. Data were collected from 78 participants between December 2025 and May 2026. Seven participants were excluded because of procedural violations: one used a phone during the task, and six did not follow the instruction to use the same response hand throughout the experiment. After these procedural exclusions, 71 participants remained, including 33 women and 38 men, aged 18–34 years (M = 20.54, SD = 2.58). Based on the Edinburgh Handedness Inventory, 67 participants were right-handed, two were left-handed, and two were ambidextrous.

Materials and Procedure

Materials, instructions, and procedure were identical to those in Experiment 1, except that the stimuli were Turkish number words rather than Arabic digits. The stimulus pool consisted of 72 spatially ordered number-word pairs corresponding to the quantities 1–9 (e.g., BİR, DOKUZ), constructed to match the digit pairs in spatial compatibility and numerical distance. Number words were presented in

uppercase Turkish letters using the same font, color, background, and spatial positions as in Experiment 1, with each word centered at the corresponding left or right position. Participants were randomly assigned to either the small-number task (N = 36) or the large-number task (N = 35).

Data Preparation and Analysis

Data filtering and statistical analyses followed the same protocol as in Experiment 1. As the first step in data preparation, we checked whether each participant had correct go-trial RTs in every numerical distance x spatial compatibility cell needed to compute participant-level mean RTs. One participant from the small-number task was excluded because one or more cells contained no correct go trials. After this exclusion, the final analytic sample consisted of 70 participants, with 35 participants in each task. Incorrect responses were excluded from the RT analyses, accounting for 5.58% of trials (4.39% commission errors and 1.19% omission errors). RTs shorter than 150 ms or exceeding ±2.5 SD from each participant's mean RT were also removed as outliers, excluding an additional 0.74% of trials. Overall, 93.67% of the data were retained for analysis.

Results

Descriptive statistics for mean RTs as a function of spatial compatibility and numerical distance for the small-number and large-number tasks are presented in SOM Table 1. Mauchly's tests indicated violations of the sphericity assumption for numerical distance and for the spatial compatibility x numerical distance interaction in both tasks; therefore, Greenhouse–Geisser-corrected degrees of freedom are reported for these effects. In the small-number task, responses tended to be faster on compatible than incompatible trials, although the main effect of spatial compatibility did not reach conventional significance, $F(1, 34) = 3.59$, $p = .067$, $\eta^2 = .095$. This effect was not significant in the large-number task, $F(1, 34) = 0.04$, $p = .839$, $\eta^2 = .001$. The main effect of numerical distance was significant in both tasks, small-number task: $F(4.06, 137.90) = 25.04$, $p < .001$, $\eta^2 = .424$; large-number task: $F(4.88, 165.77) = 44.36$, $p < .001$, $\eta^2 = .566$. Linear polynomial contrasts showed significant linear trends in both tasks, small-number task: $F(1, 34) = 190.49$, $p < .001$, $\eta^2 = .849$; large-number task: $F(1, 34) = 230.04$, $p < .001$, $\eta^2 = .871$, indicating that RTs decreased as numerical distance increased. The spatial compatibility x numerical distance interaction was not significant in either task (Figure 2), small-number task: $F(4.69, 159.32) = 1.66$, $p = .151$, $\eta^2 = .047$; large-number task: $F(4.31, 146.47) = 1.09$, $p = .366$, $\eta^2 = .031$.

Descriptive statistics for the overall distance slopes and compatibility-specific distance slopes in the small-number and large-number tasks are presented in SOM Table 2. The overall distance slope was significantly below zero in the small-number task, $t(34) = -13.56$, $p < .001$, Cohen's $dz = 2.29$, and in the large-number task, $t(34) = -15.45$, $p < .001$, Cohen's $dz = 2.61$, indicating a numerical distance effect in both tasks. Compatibility-specific slope comparisons showed that the distance slopes did not differ between compatible and incompatible trials in either the small-number task, $t(34) = -1.36$, $p = .184$, Cohen's $dz = 0.23$, or the large-number task, $t(34) = .98$, $p = .334$, Cohen's $dz = 0.17$.

Discussion

Experiment 2 extended the pairwise go/no-go task to Turkish number words. Numerical distance effects emerged in both the small-number and large-number tasks, paralleling Experiment 1 and indicating that written verbal notation supported relative-magnitude processing in this task. Evidence for stimulus-arrangement compatibility was again limited. The small-number task showed a tendency toward faster responses for compatible than incompatible arrangements, but this effect did not reach conventional significance and was not observed in the large-number task.

Unlike Experiment 1, the compatibility-related tendency in Experiment 2 did not extend to the distance-based measures: the spatial compatibility x numerical distance interaction was not significant, and distance slopes did not differ between compatible and incompatible arrangements in either task. Thus, any evidence for compatibility with Turkish number words was confined to a weak overall RT tendency in the small-number task.

Overall, Experiment 2 showed robust distance-based magnitude effects for Turkish number words, with no robust or general arrangement-based compatibility advantage. Taken together, the two experiments suggest that the pairwise go/no-go task reliably engaged relative-magnitude processing with both Arabic digits and Turkish number words, whereas evidence for conventional small-left/large-right compatibility was weak and task-dependent.

General Discussion

Across two experiments, the present study examined whether relative-magnitude processing in a pairwise go/no-go magnitude-comparison task would be accompanied by a performance advantage for the conventional small-left/large-right arrangement. Arabic digits and Turkish number words both produced robust numerical distance effects across the small-number and large-number tasks, indicating successful access to relative numerical magnitude across symbolic formats. In contrast, evidence for stimulus-arrangement compatibility was weaker and more task-dependent. Compatible arrangements did not produce a general RT advantage across tasks and notations, and compatibility did not consistently modulate the numerical distance effect. Although compatibility-related patterns emerged in limited forms, they were restricted to the small-number task: for Arabic digits, compatibility appeared in the distance slopes, whereas for Turkish number words, it appeared only as a tendency in mean RTs. Thus, relative-magnitude processing was robust across symbolic formats, whereas the behavioral expression of arrangement-based spatial compatibility was more selective and dependent on task context. The results suggest that relative-magnitude processing and arrangement-based spatial compatibility do not necessarily covary when explicit left–right response selection is minimized.

The most consistent result was the numerical distance effect, which appeared across both experiments and task versions. Here, the distance effect served as a behavioral marker of relative-magnitude processing, rather than as direct evidence for a spatially organized mental number line. Participants responded faster as the numerical distance between the two presented symbols increased, indicating that the pairwise single-response go/no-go format preserved the core magnitude-comparison process

while reducing the need to select between spatially defined left and right responses. This finding converges with recent evidence that numerical distance effects can emerge in go/no-go magnitude-classification tasks using different numerical formats and spatial layouts (Bourgaux et al., 2023; Eccher et al., 2025; Jeglinski-Mende et al., 2023). Importantly, these studies used single stimuli evaluated relative to a reference value. The present findings extend this evidence to pairwise magnitude comparison, showing that participants can access the relative magnitude relation between two simultaneously presented symbols under a single-response format.

The distance effect also extended to Turkish number words, indicating that written verbal number symbols can support relative-magnitude processing in the present pairwise go/no-go task. This finding fits with previous evidence that written number words can provide access to numerical magnitude when participants are explicitly required to evaluate numerical value (Cohen Kadosh et al., 2008; Lukas et al., 2014; Wong et al., 2018). Lukas et al. (2014), for example, showed that numerical distance effects for number words can differ across languages and may depend partly on surface-level perceptual properties of the written word forms. Therefore, the distance effects observed for both Arabic digits and Turkish number words in the present study should not be taken as evidence for notation independence, because notation was examined across separate experiments rather than manipulated directly within a single design. Instead, the findings show that the pairwise go/no-go comparison task was sensitive to relative magnitude across both symbolic formats.

In contrast to the consistent numerical distance effects, evidence for arrangement-based spatial compatibility was limited and did not form a stable pattern across experiments. Compatible small-left/large-right arrangements did not produce a general RT advantage, and spatial compatibility did not consistently modulate the numerical distance effect. The few compatibility-related patterns that emerged were restricted to the small-number task and differed in form across notations. Therefore, these findings do not support the conclusion that robust numerical distance effects necessarily give rise to a stable small-left/large-right advantage. The present findings therefore speak most directly to the absence of a robust or general arrangement-based compatibility advantage under the present task conditions, rather than to the complete absence of any spatial influence.

This selective pattern fits with previous work showing that directional spatial–numerical associations are shaped by how magnitude, spatial position, and response requirements are configured within a given task. Pairwise comparison studies using lateralized response alternatives have reported spatial compatibility or SNARC-like patterns, suggesting that left–right response selection may support the behavioral expression of number–space mappings (Shaki et al., 2012). However, spatial effects in pairwise comparison are not always stable. Patro and Shaki (2016) showed that numerosity–space mappings varied with comparative instruction, and Ordin et al. (2026) likewise found no larger-right advantage in a pairwise symbolic-number comparison task: responses were not faster or more accurate when the larger number appeared on the right rather than on the left. Studies using go/no-go or single-response formats further indicate that directional spatial–numerical effects are not obligatory when explicit left–right response selection is reduced and may depend on how magnitude and spatial codes

are integrated within the task (Pinto et al., 2019, 2021; Bulut et al., 2026). The present findings extend this task-sensitive view to pairwise magnitude comparison by showing that the simultaneous presentation of two numerical symbols with a central response key does not by itself guarantee a stable or general small-left/large-right advantage.

The notation-related findings should also be interpreted cautiously. Although both formats yielded reliable numerical distance effects and neither produced a general arrangement-based compatibility advantage, the limited compatibility-related patterns were not identical across notations: for Arabic digits, the effect appeared only in the distance-slope pattern of the small-number task, whereas for Turkish number words, it was confined to a weak RT tendency in the small-number task. Thus, the findings do not indicate that verbal notation strengthens SNAs. Rather, they fit with previous notation studies showing that spatial–numerical effects for number words vary across tasks and processing demands, with some studies reporting comparable effects across notations and others showing task-dependent or notation-specific patterns (Fias, 2001; Gong et al., 2019; Hung et al., 2008; Nuerk et al., 2004, 2005).

The limited compatibility effects observed here may also be considered in relation to previous findings from Turkish samples. Although Turkish is written from left to right, prior studies have reported absent or task-dependent SNARC/SNA effects in Turkish participants across different paradigms (Bulut et al., 2023, 2026; Dural et al., 2025). Therefore, the present pattern may partly reflect the weak or inconsistent expression of directional SNAs previously observed in Turkish samples. At the same time, the results are also compatible with a task-configuration account, as the pairwise go/no-go format produced robust numerical distance effects without a stable or general small-left/large-right compatibility advantage.

The present results point to a distinction between accessing relative magnitude and expressing arrangement-based spatial compatibility in behavior. Whereas the distance effect indexed relative-magnitude processing, arrangement-based compatibility tested whether that information was also expressed as a behavioral advantage for the conventional small-left/large-right arrangement. These two measures did not vary in parallel: distance effects were robust across tasks and notations, whereas compatibility-related effects were weak, task-dependent, and not consistently reflected in the distance function. This fits with previous evidence suggesting that SNARC and distance effects need not always reflect a single unitary mechanism: SNARC effects can be modulated by both numerical distance and response-related factors (Basso Moro et al., 2018), and numerical distance effects do not always correlate with SNARC measures across tasks (Fattorini et al., 2015). Thus, relative-magnitude processing can be engaged without necessarily producing a stable or general arrangement-based spatial-compatibility advantage.

Because the two notations were tested in separate experiments conducted at different time points, and participants were not randomly assigned to notation conditions within a single design, the present study does not allow strong inferential conclusions about notation effects. Although the descriptive statistics for Arabic digits and Turkish number words are presented side by side in SOM Table 1 for transparency

and ease of comparison, these values should be interpreted descriptively rather than as evidence for statistically reliable differences between notations. The relevant conclusion is therefore not that one notation produced stronger or weaker effects than the other, but that the same broad pattern emerged across symbolic formats: robust numerical distance effects accompanied by limited and task-dependent evidence for arrangement-based compatibility.

In conclusion, the present study shows that pairwise go/no-go magnitude comparison reliably engages relative numerical magnitude across Arabic digits and Turkish number words. However, this robust distance-based magnitude processing was not accompanied by a stable or general advantage for the small-left/large-right arrangement. The findings support a distinction between relative-magnitude access and the behavioral expression of arrangement-based spatial compatibility. Spatial–numerical mappings may not simply be read out from magnitude representations; rather, their behavioral expression depends on how magnitude, space, notation, and response requirements are configured within the task.

Declarations

Ethics Approval:

The study was approved by the Ethics Committee of İzmir University of Economics (approval number: E-97429853-050.04-88740).

Consent to Participate:

All participants provided informed consent prior to participation.

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Author Contribution

All authors contributed equally to this work.

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Data and Code Availability:

The complete dataset for this study, including raw data, participant-level aggregate data, SPSS data files, and analysis scripts for data filtering and processing, is publicly available on the OSF at: https://osf.io/6yaxt.

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Figures

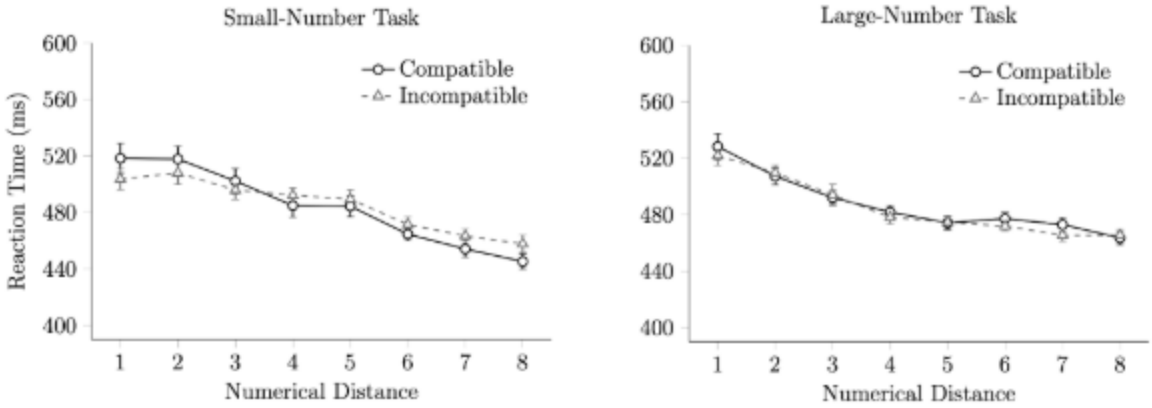

Figure 1

Mean RTs as a function of numerical distance and spatial compatibility for the small-number and large-number tasks in Experiment 1. Error bars represent ±1 SEM adjusted for repeated measures.

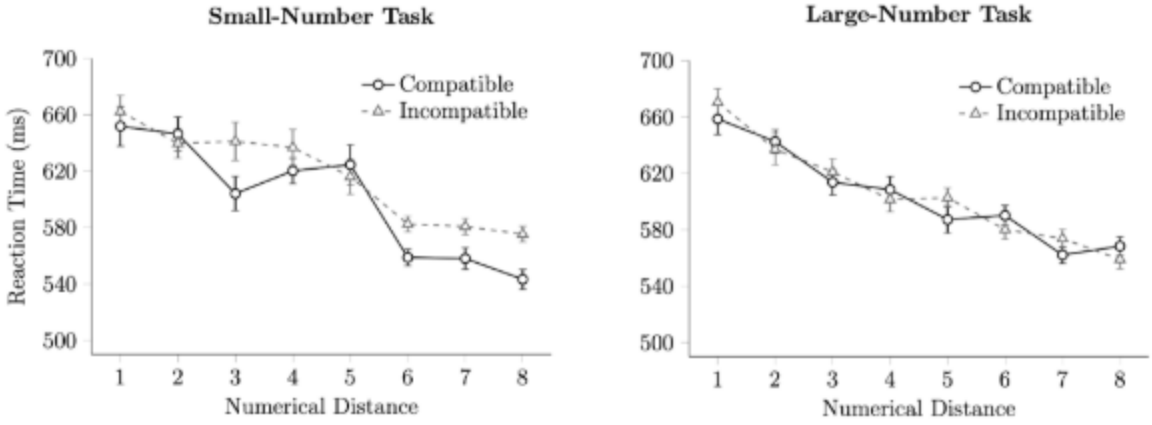

Figure 2

Mean RTs as a function of numerical distance and spatial compatibility for the small-number and large-number tasks in Experiment 2. Error bars represent ±1 SEM adjusted for repeated measures.

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