Local and global level-priming occurs for hierarchical stimuli composed of outlined, but not filled-in, elements

Alexandra List
Department of Psychology, Northwestern University, Evanston, IL, USA
Marcia Grabowecky
Department of Psychology, Northwestern University, Evanston, IL, USA
Interdepartmental Neuroscience Program, Northwestern University, Evanston, IL, USA
Satoru Suzuki
Department of Psychology, Northwestern University, Evanston, IL, USA
Interdepartmental Neuroscience Program, Northwestern University, Evanston, IL, USA

When attention is directed to the local or global level of a hierarchical stimulus, attending to that same scale of information is subsequently facilitated. This effect is called level-priming, and in its pure form, it has been dissociated from stimulus- or response-repetition priming. In previous studies, pure level-priming has been demonstrated using hierarchical stimuli composed of alphanumeric forms consisting of lines. Here, we test whether pure level-priming extends to hierarchical configurations of generic geometric forms composed of elements that can be depicted either outlined or filled-in. Interestingly, whereas hierarchical stimuli composed of outlined elements benefited from pure level-priming, for both local and global targets, those composed of filled-in elements did not. The results are not readily attributable to differences in spatial frequency content, suggesting that forms composed of outlined and filled-in elements are treated differently by attention and/or priming mechanisms. Because our results present a surprising limit on attentional persistence to scale, we propose that other findings in the attention and priming literature be evaluated for their generalizability across a broad range of stimulus classes, including outlined and filled-in depictions.

Introduction

At any given moment, behavior occurs within the context of preceding events. The influence of a preceding event on current behavior is referred to as priming. Priming typically manifests as faster responses to a stimulus when properties of the preceding stimulus repeat. In vision, these properties can include position, color, motion, shape, and object identity (e.g., Biederman & Cooper, 2009; Cooper, Biederman, & Hummel, 1992; Grice & Gwynne, 1985; Kirby, 1980; Kornblum, 1973; Kristjansson & Campana, 2010; Magnussen, 2000; Maljkovic & Nakayama, 1994, 1996; Pashler & Baylis, 1991; Pinkus & Pantle, 1997; Suzuki & Goolsby, 2003). The present research focuses on a particular form of priming in which attending and responding to a certain scale of a hierarchical stimulus influence the subsequent scale of attention.

In 1982, Ward presented a series of hierarchical stimuli, akin to those introduced by Navon (1977), and asked participants to identify a form (± or ×) at the local or global level. In different blocks, participants identified the forms in pairs of trials in a particular sequence (global then global, local then local, global then local, or local then global). In blocks in which the target form was sequentially presented at the same level, response times (RTs) were faster than when the target’s level changed. This so-called level-priming was found whether participants identified local or global forms.

Although it may not seem surprising that sustaining attention to a local or global level facilitates RTs compared with alternating attention between local and global levels, two important extensions of this
result have been reported. First, level-priming can occur on a trial-by-trial basis in divided-attention tasks, in which participants report one of two target letters that are equiprobably and unpredictably presented at the local or global level. In these cases, participants have no incentive to voluntarily sustain or switch their attention from one level to another, yet an advantage for repeated-level compared with changed-level target identification manifests (e.g., Han, He, & Woods, 2000; Kim, Ivry, & Robertson, 1999; Lamb & Yund, 1996; Qin & Han, 2007; Robertson, 1996; Schatz & Erlandson, 2003; Wendt, Vietze, & Kluewe, 2007). Second, and importantly for our purposes, level-priming has been dissociated from response- and stimulus-priming: Repeated-level targets are facilitated compared with changed-level targets even when the target pattern and response changes (see e.g., Filoteo, Friedrich, & Stricker, 2001; Robertson, 1996). These results suggest that level-priming is an automatic bias to sustain the scale of attention from one moment to the next. The goal of the current study was to extend the prior results of level-priming in three ways.

First, we used stimuli that are not overlearned alphanumeric forms. To our knowledge, studies that have reported “pure” level-priming effects uncontaminated by stimulus and response priming (when the target pattern and response change) have restricted their hierarchical stimuli to those composed of alphanumeric forms (e.g., Filoteo et al., 2001; Lamb & Yund, 1996; Robertson, 1996). In studies that have used other forms, such as symbolic forms (e.g., arrows), objects, or unnamable shapes, either level-priming was not examined (e.g., Brown & Kosslyn, 1995; Fink et al., 1997; Martinez et al., 1997) or it was never dissociated from stimulus- and response-priming (e.g., Han et al., 2000; Qin & Han, 2007; Wendt et al., 2007). Therefore, it remains unknown whether hierarchical stimuli other than those composed of alphanumeric forms benefit from attentional priming to scale.

Historically, alphanumeric characters were adopted because they made low recognition demands on the observers. Namely, Navon (1977) claimed that “the best way to equate the properties of global and local features is to use stimuli in which the set of possible global features is identical with the set of possible local ones. For this purpose I constructed large letters that were made out of small letters . . . whose identities are also definitely recognizable” (p. 358), and Kinchla (1977) “utilize[d] an observer’s highly trained ability to recognize alphabetic forms” (p. 20). However, our visual environment is not always composed of easily recognizable forms. Thus, if hierarchical stimuli are used as an experimental simplification of the complex multilevel natural visual environment, by using only alphanumeric forms, we restrict our ability to generalize about perceptual and attentional mechanisms that are engaged under natural hierarchical viewing conditions. If we want to extend our conclusions about hierarchical processes beyond overlearned meaningful forms, a wider variety of stimuli must be tested. Thus, in the following studies, we tested the generalizability of level-priming by adopting generic geometric patterns (√/√√), instead of alphanumeric characters, as the basis for the hierarchical stimuli.

Second, we used both two- and three-level hierarchical stimuli. In the majority of level-priming studies employing hierarchical stimuli, there exists an asymmetry in grouping requirements across the local and global levels (cf., Kim et al., 1999; Robertson, 1996, experiment 3). Namely, grouping of discrete local elements is required to recognize the global pattern, whereas grouping of discrete elements is not necessary to recognize the local pattern (because the line segments forming the local pattern are typically connected). Thus, the local pattern benefits from connectedness whereas the global pattern does not. To avoid this confound, we presented three-level hierarchical stimuli in which identification of the local patterns also required grouping of discrete elements (here, circles). However, in an effort to be able to directly assess the influence, if any, of two- versus three-level hierarchical processing on pure level-priming, other participants saw two-level hierarchical stimuli created by connecting the elements forming the local patterns.

Third, we used filled-in and outlined stimuli. Closed two-dimensional shapes, such as the circles we used to create the local patterns, can be depicted as filled-in or outlined. Filled-in and outlined shapes differ in their subjective appearance. For example, a filled-in circle might be perceived as a sphere, disk, or a hole, whereas an outlined circle might be perceived as a ring or a schematic depiction of a sphere or disk. In visual studies of two-dimensional form perception and aftereffects, outlined forms are commonly used (e.g., Regan & Hamstra, 1992; Suzuki, 2001, 2003, 2005; Suzuki & Cavanagh, 1998; Sweeney, Grabecky, & Suzuki, 2011), whereas studies on grouping and visual search use filled-in and/or outlined forms (e.g., Grabecky, Robertson, & Treisman, 1993; Kimchi, 1998; List et al., 2008; Palmer & Bucher, 1981). In none of these cases is an explicit reason given as to why filled-in or outlined forms were used; there appears to be an implicit assumption that results with filled-in forms would generalize to outlined forms and vice versa. Without an explicit reason to use filled-in or outlined circles, we used each in separate groups of participants. The use of both stimulus sets turned out, serendipitously, to reveal an important limitation on the presence of attentional persistence to scale.
Experiment

Methods

Participants

Ninety-one Northwestern University undergraduate students gave informed consent and received course credit for their participation. All had normal or corrected-to-normal vision. Participants were excluded for failing to reach criterion performance (n = 8, described below), excessive errors (n = 16, greater than 10%), noncompliance with instructions (n = 1), experimenter error (n = 1), and equipment failure (n = 1). Of the remaining 64 participants (M = 19 years old), 39 are women and all but four are right-handed. Sixteen participants were included in each of four between-subject stimulus conditions: filled-in-unconnected (seven women and one left-hander, after nine were excluded), outlined-unconnected (seven women and no left-handers, after five were excluded), filled-in-connected (13 women and three left-handers, after seven were excluded), and outlined-connected (12 women and no left-handers, after six were excluded).

Apparatus

Stimulus presentation and response recording was controlled by Presentation software (www.neurobs.com). Participants were seated ~57 cm from a color CRT monitor, with a 1024 × 768 resolution and 60-Hz refresh rate. A Cedrus response box (RB-834) was used to collect manual responses.

Stimuli

Local patterns were created by arranging three circles into one of four formations: \( \bullet \bullet \bullet \), (circles were either filled-in, as depicted here, or outlined). Three (of the same) local patterns were presented to form a global pattern (again, \( \bullet \bullet \bullet \), here each circle represents a local form). Hierarchical stimuli were created from the \( 2 \times 2 \times 2 \) factorial crossing of initially-rising pattern \( \bullet \bullet \bullet \bullet \), initially-falling pattern \( \bullet \bullet \bullet \bullet \), and the level of the initially-rising pattern (local or global; by necessity, the initially-falling pattern is presented at the other level). This resulted in eight hierarchical stimuli in which local and global patterns were always different from one another within each stimulus (Figure 1).

Four types of hierarchical stimuli were created from the combination of element connectedness (connected or unconnected) and depiction (filled-in or outlined; Figure 2).

Circles were each 0.7° in diameter. When circles were connected by bars, the bar width was 0.4° (Figure 2, bottom). For outlined conditions, the line width was 0.12°. Within each local pattern, neighboring circles were spaced 0.85° center to center. Between local patterns, neighboring circles were spaced 1.7° center to center. The maximum extent of the global pattern spanned 9.5° × 9.5°. A central black dot (0.3° diameter) was used as a fixation point. All stimuli were black presented on a white background.

Procedure

Participants were assigned two target patterns (either initially-rising \( \bullet \bullet \bullet \bullet \) or initially-falling \( \bullet \bullet \bullet \bullet \)).
counterbalanced across participants. Each target pattern had an associated response button and was also counterbalanced across participants. Participants were instructed to use their index fingers to respond as quickly and as accurately as possible. They were shown an illustration of the eight possible stimuli, told which was the appropriate response for each stimulus, and informed that only one assigned target pattern would be present at either the local or global level.

In a 16-trial familiarization block, each stimulus was presented twice. Participants were then allowed up to four 16-trial practice blocks in which to reach 14 or more correct trials before beginning the experiment. On average, participants needed 1.81 practice blocks (SD = 1.05) to reach criterion.

In the familiarization trials, a central fixation dot appeared for 1 s, followed by a hierarchical stimulus that remained on the screen until a correct response was made, without intertrial intervals. In the practice and experimental trials, a central fixation dot was presented for 1 s, followed by a hierarchical stimulus for 100 ms. The fixation dot reappeared immediately for 1 s or until a response was made. A 1.5-s blank intertrial interval followed. If a response was not made by the end of the intertrial interval, the trial was classified as miss.

Within each of the four experimental blocks, each of the eight stimuli (see Figure 1) followed every other stimulus equally often. The first stimulus was repeated as the last stimulus to measure the priming effect on it, yielding 65 trials per block. Within each block, trial order was fixed. Block order was counterbalanced across participants according to a Latin square design. Breaks were allowed between blocks.

Results

The RTs and error rates were submitted to a mixed-design analysis of variance with depiction (filled-in or outlined) and connectedness (unconnected or connected) as between-subjects factors, and target level (local or global), target-priming (repeated-target or changed-target), and level-priming (repeated-level or changed-level) as within-subjects factors (see Appendix, Table 1, for the mean RT and error rate). The RT analyses were conducted on correct responses within 3 SDs of each individual’s mean (outliers M = 1.3%). Errors (M = 4.5%), misses (M = 0.1%) and outliers, and trials immediately following those (M = 5.7%); to avoid contaminating priming effects) were excluded from RT analyses. Alpha was set at the 0.05 level.

A main effect of level-priming was found in RTs: F(1, 60) = 97.0, p < 0.001, ηp² = 62. The RTs were 38 ms faster for repeated-level targets than for changed-level targets. A similar effect of level-priming was found in the error rates: F(1, 60) = 9.6, p = 0.003, ηp² = 14, which were lower for repeated-level (3.8%) compared with changed-level (4.9%) targets. No other main effects were reliable for RTs, level: F(1, 60) = 2.3, n.s.; target-priming: F(1, 60) = 3.1, n.s., depiction: F(1, 60) = 1.6, n.s., connectedness: F(1, 60) = 0.7, n.s., or in error rates, level: F(1, 60) = 1.2, n.s.; target-priming: F(1, 60) = 0.8, n.s., depiction: F(1, 60) = 2.6, n.s., connectedness: F(1, 60) = 0.03, n.s.

An interaction between level-priming and target-priming was present in RTs, F(1, 60) = 74.6, p < 0.001, ηp² = 55, and in errors, F(1, 60) = 17.2, p < 0.001, ηp² = 0.22. When the target pattern repeated, RTs were 62 ms faster and responses were 2.6% more accurate when the level also repeated versus changed. RTs: t(63) = 13.1, p < 0.001, d = 1.64 and errors: t(63) = 5.0, p < 0.001, d = 0.63. Although reduced, when the target pattern changed, RTs were reliably faster when the level repeated versus changed, 14 ms, t(63) = 2.9, p = 0.006, d = 0.36, with no reliable difference between errors for repeated- versus changed-level: 0.4%, |d| < 1. Thus, although pure level-priming was present overall for RTs, it was weak.

Importantly, the level-priming by target-priming interaction was qualified by stimulus depiction, F(1, 60) = 7.7, p = 0.007, ηp² = 0.11, for RTs (Figures 3 and 4). Namely, when the target repeated, RTs were faster for repeated versus changed level in both the filled-in and
outlined conditions: Filled-in, 68 ms, $t(31) = 9.8, p < 0.001, d = 1.73$, and outlined, 56 ms, $t(31) = 8.9, p < 0.001, d = 1.57$. Thus, identity priming (i.e., RT benefit of an identical target and response) occurred regardless of depiction (filled-in or outlined). In contrast, when the target changed, RTs were only 4 ms faster for repeated versus changed level in the filled-in condition, $|t| < 1$, whereas they were 23 ms faster for the outlined condition, $t(31) = 3.4, p = 0.002, d = 0.59$. Thus, pure level-priming occurred only for the outlined, but not for the filled-in, stimuli. Furthermore, pure level-priming was remarkably similar across levels: 23 ms for local and global outlined conditions ($|t| > 2.5, ps < 0.02$), and 1 and 7 ms, respectively, for filled-in conditions ($|t| < 1$). Therefore, pure level-priming occurs independently of level but only for outlined elements. No other reliable interactions were found for RTs.

Error analyses revealed two additional interactions. A level-priming by depiction by connectedness interaction, $F(1, 60) = 4.1, p = 0.05, \eta^2_p = 0.06$, showed that overall level-priming (averaged for repeated and changed targets) was present for all conditions ($|t| > 2.4, ps < 0.05$) except for outlined connected stimuli, $|t| < 1$. Note that this interaction reflects a lack of both pure level-priming and identity priming for the outlined connected stimuli in errors ($|t| < 1.6, ps > 0.13$), whereas the other conditions showed at least marginal identity priming ($|t| > 2.0, ps < 0.06$) but no pure level-priming ($|t| < 1.4, ps > 0.19$) in errors. The second interaction was between level-priming, target-priming, depiction, and connectedness, $F(1, 60) = 6.8, p = 0.01, \eta^2_p = 0.10$. For outlined connected stimuli, errors were greater for global repeated versus changed targets, $t(15) = 3.1, p = 0.007, d = 0.79$, and were reduced for local repeated versus changed targets, $t(15) = 2.1, p = 0.054, d = 0.52$. No error differences were found for any of the other depiction by connectedness conditions ($|t| < 1.6, ps > 0.13$). Importantly, none of these error effects presented any evidence of a speed-accuracy tradeoff.

The results indicate that filling-in is what influences the presence or absence of pure level-priming: Unlike hierarchical stimuli composed of outlined elements, hierarchical stimuli composed of filled-in elements do not engage level-specific attentional persistence.

**Discussion**

Persistence of attention to scale has been demonstrated as pure level-priming, a benefit for sequential
processing of information at the local or global level independent of stimulus and response priming (e.g., Filoteo et al., 2001; Robertson, 1996). However, previous level-priming studies have predominantly used two-level hierarchical stimuli composed of alphanumeric forms (see the Introduction). The goal of the current study was to evaluate the generalizability of pure level-priming. We determined whether pure level-priming generalized to generic (nonalphanumeric) forms, presented as two- or three-level hierarchical stimuli (the latter requires grouping for identifying both the local and global forms, whereas the former requires grouping only for identifying the global forms as in most previous studies using alphanumeric forms (see the Introduction). The goal of the current study was to evaluate the generalizability of pure level-priming. We determined whether pure level-priming generalized to generic (nonalphanumeric) forms, presented as two- or three-level hierarchical stimuli (the latter requires grouping for identifying both the local and global forms, whereas the former requires grouping only for identifying the global forms as in most previous studies using alphanumeric hierarchical stimuli), with local forms composed of closed elements that were filled-in or outlined (this manipulation was never used in previous studies using alphanumeric forms, which were typically composed of line segments). We have demonstrated that pure level-priming generalizes to generic geometric forms and also to three-level hierarchical stimuli. However, our results suggest a surprising conclusion that persistence of attention to scale occurs when hierarchical stimuli are depicted with outlined elements (replicating prior studies using alphanumeric forms) but does not occur when hierarchical stimuli are depicted with filled-in elements.

Why does such a seemingly minor stimulus difference, filled-in versus outlined elements, determine whether or not pure level-priming occurs? One might argue that perceptual grouping differs when elements are filled-in versus outlined circles. However, we find no direct evidence for this claim. First, overall RTs did not differ between stimulus depictions; although RTs appear to be somewhat longer for outlined than filled-in stimuli, the difference was statistically unreliable, $F(1, 60) = 1.6$, n.s. (Figures 3 and 4; note that the within-subjects error bars shown are not appropriate for making this between-subjects comparison). Thus, performance was roughly equated across the filled-in and outlined stimulus sets. Second, where we might have seen a difference based on a direct grouping manipulation, for connected versus unconnected stimuli (connected parts are treated differently than segmented ones, e.g., Franconeri, Bemis, & Alvarez, 2009; Palmer & Rock, 1994; Saiki & Hummel, 1998; Xu, 2006), we found no local target RT difference, $t(62) = 1.07$, n.s. This suggests that the difficulty for
identifying the local patterns was equivalent whether the
constituent circles were connected or unconnected.
Third, if we examine local and global RTs, assuming
that these levels may be differentially affected by
grouping processes that might differ for filled-in and
outlined stimuli, we failed to find any main effects of
level, $F(1, 60) = 2.3$, n.s., or depiction, $F(1, 60) = 1.6$,
n.s., or an interaction between the two, $F(1, 60) = 1.19$.
n.s. Furthermore, in a direct comparison of filled-in and
outlined stimuli, RTs for local or global targets were
equivalent, |t| < 1.5, n.s. Thus, although null effects
limit our ability to conclusively argue against grouping
differences across levels, the difficulty of grouping
circles to identify a local pattern and that of grouping
local patterns to identify a global pattern were
statistically undifferentiated for our filled-in and
local patterns. Nevertheless, the
statistically undifferentiated for our filled-in and
outlined stimuli.

Another possible account of the difference in pure
level-priming between filled-in and outlined stimuli is
the difference in their spatial frequency profiles. Spatial
frequency information has been consistently shown to
be related to local-global processing (e.g., Flevaris,
Bentin, & Robertson, 2011; Shulman, Sullivan, Gish, &
Sakoda, 1986; Shulman & Wilson, 1987). Most relevant
to the current findings, Robertson (1996) showed that
level-priming was eliminated if contrast-balanced
stimuli (in which low-spatial-frequency information is
minimized) were used. However, based on Robertson's
results, we would have expected the outlined circles to
show less level-priming than did the filled-in circles
because the outlined circles have relatively less low-
spatial-frequency information than do the filled-in
circles. This prediction is opposite to what we found.
(Note, however, that compared with contrast-balanced
stimuli, our stimuli, whether composed of filled-in or
outlined elements, had considerably greater low-spa-
tial-frequency information.) Therefore, it is unlikely
that the differences in the spatial frequency content of
the stimuli influenced the level-priming results reported
here.

Future research is necessary to explain why filled-in
versus outlined depictions of elements makes a critical
difference in pure level-priming. Nevertheless, the
current results pinpoint an interesting dissociation.
When a target form and response is repeated (leftmost
bars, Figures 3 and 4), repeating its level (local or
global) facilitates performance irrespective of whether
the elements are filled-in or outlined. In other words,
with filled-in or outlined elements, attending to a

specific form presented at a specific level (e.g., a local
facilitates subsequent identification of the same
form presented at the same level (e.g., a local
compared with a different level (e.g., a global).
This
contrasts with the fact that when the target form and
response change, only when the stimulus elements are
outlined is there a general (stimulus nonspecific) benefit
of sequentially attending to the same level. Thus,
priming of identity (including form and level) general-
izes to both filled-in and outlined stimuli, but general
priming of level (irrespective of form) is abolished when
the stimuli are filled-in.

The current findings also make an important
theoretical contribution, addressing two potential
confounds in interpreting whether level-priming is the
result of an implicit or explicit process. Whether using
hierarchical stimuli or not, priming of alphanumeric (or
even nonsense) forms may reflect explicit verbalization
priming instead of implicit perceptual priming. For
example, a participant mentally verbalizing “X” in one
trial followed by mentally verbalizing “X” versus “Y”
in the following trial could produce priming effects
(where X and Y represent target forms). In the case of
pure level-priming, although the verbalization of the
target cannot account for the priming effects, verbal-
ization of the level could. Consider, for example, a
participant mentally verbalizing “global X” in one trial
and mentally verbalizing “global Y” versus “local Y” in
the following trial. In this case, so-called pure level-
priming could be attributed to the repetition of
“global” or “local” verbalizations, instead of global or
local perceptual processing. Accordingly, it could be
argued that prior reports of level-priming (even pure
level-priming) could instead reflect verbalization prim-
ing. Alternatively, level-priming could arise if parti-
cipants adopted the explicit strategy of sustaining their
attention to the last attended level without being given
an incentive to shift their attention. Thus, prior pure
level-priming results could be attributed to either
priming of level verbalization or explicit strategizing.
However, our results argue against both of these
possibilities. Here, we have reported robust pure level-
priming using stimuli with outlined elements and no
reliable pure level-priming using stimuli with filled-in
elements. There is no obvious reason to suspect that
filling-in would provoke participants to adopt different
verbalization or explicit attentional allocation strate-
gies. Thus, the present results suggest that pure level-
priming effects found here and elsewhere are not due to
verbalization priming or to a strategic sequential
allocation of attention and instead support the claim
that pure level-priming is due to an automatic
persistence of attention to perceptual scale.

Finally, our results have a cautionary broader
implication. The results of many visual studies are
typically assumed to generalize across what might be

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**Equations**

$$F(1, 60) = 2.3$$

$$F(1, 60) = 1.6$$

$$F(1, 60) = 1.19$$

$$|t| < 1.5$$

$$|t| < 1$$

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**Tables**

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<thead>
<tr>
<th>Table 1: Results of Level-Primed RTs</th>
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<td>-------------</td>
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<td>Local</td>
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<td>Global</td>
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<td>Filled-In</td>
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**Figures**

Figures 3 and 4: Comparing filled-in and outlined stimuli.
considered small stimulus changes. As a result of trying to generalize pure level-priming from a special class of hierarchical stimuli (using alphanumeric forms) to generic geometric stimuli, we found that a small stimulus change (filling-in of elements) unexpectedly had a dramatic consequence on the sequential allocation of visual attention to scale. Our results serve as a reminder to test perceptual and attention effects across broad varieties of stimuli and caution against the persistent use of special classes of stimuli for broader generalizability.

Conclusions

To determine whether or not the persistence of attention to scale generalizes beyond the special class of alphanumeric hierarchical stimuli, we examined level-priming for hierarchical figures composed of generic forms. We found pure level-priming, independent of stimulus and response repetition, for generic forms and for two- and three-level hierarchical stimuli, although it was selective for hierarchical stimuli in which the elements making up the local forms were outlined (but not filled in). This surprising result cannot be attributed to differences in grouping or the spatial frequency profiles of the filled-in versus outlined stimuli. Furthermore, identity priming, unlike level-priming, is robust for both filled-in and outlined stimuli. Although the reason for these priming dissociations remains to be explained, the current results make two additional contributions. First, when pure level-priming is reported here or elsewhere, it is likely to be the result of an automatic attentional persistence to perceptual scale and not due to explicit verbalization priming or attentional strategies. Second, the results highlight the need to test a variety of stimuli to ascertain the generalizability of attention and priming effects more broadly.

Keywords: priming, local, global, attention, hierarchical stimuli

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Corresponding author: Alexandra List.
Email: a-list@northwestern.edu.
Address: Department of Psychology, 2029 Sheridan Road, Northwestern University, Evanston, IL 60208.

Footnotes

1 We have arbitrarily adopted terms to clarify the stimulus design. By “initially,” we refer to the leftmost element relative to the middle element. “Rising” refers to a southwest-to-northeast relationship, and “falling” refers to a northwest-to-southeast relationship between the two initial elements.

2 Because of experimenter error, two of these participants were allowed five practice blocks to achieve criterion.

3 An additive model of target-priming and level-priming predicts the best performance when both factors repeat, worst performance when both factors change, and intermediate performance for the two conditions in which one factor repeats and the other changes. Our results deviate from this model. One plausible account is that when the level changed, participants were biased to also change their response even though responses were made on the orthogonal dimension of target pattern (for other examples, see, e.g., Kleinsorge, 1999; Notebaert & Soetens, 2003). This “change-change” bias would have the concomitant effects of overestimating identity priming (by potentially increasing RTs in the changed-level repeated-target condition) and underestimating pure level-priming (by potentially reducing RTs in the changed-level changed-target condition). However, it does not alter our conclusion that outlined stimuli show significantly stronger pure level-priming effects than do filled-in stimuli.

References


Fink, G. R., Marshall, J. C., Halligan, P. W., Frith, C.


<table>
<thead>
<tr>
<th>Level</th>
<th>Target-priming</th>
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<th>Response times (SE)</th>
<th>Error rates (SE)</th>
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<td>Mean and Diffs.</td>
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<td>737 (34) PL-p 23** (8)</td>
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<td>714 (24) PL-p 23* (9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Changed-level</td>
<td>692 (30)</td>
<td>737 (29)</td>
</tr>
</tbody>
</table>

Table 1. Notes: Means and SEs for response times (ms) and error rate (proportion) for each depiction condition, broken down by level (global vs. local), target-priming (repeated-target vs. changed-target), and level-priming (repeated-level vs. changed-level). Reaction time differences between repeated and changed level are shown to illustrate pure level-priming (changed-level minus repeated-level for changed-target; second and fourth rows) and identity priming (changed-level minus repeated level for repeated-target; first and third rows). *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001, Diffs. = differences between repeated and changed level; ID-p = identity-priming; PL-p = pure level-priming.