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Timothy J. Perfect^a; Nicola J. Weston^a; Ian Dennis^a; Amelia Snell^a
^a University of Plymouth, Plymouth, UK

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Short article

The effects of precedence on Navon-induced processing bias in face recognition

Timothy J. Perfect, Nicola J. Weston, Ian Dennis, and Amelia Snell

University of Plymouth, Plymouth, UK

Macrae and Lewis (2002) showed that repeated reporting of the global dimension of Navon stimuli improved performance in a subsequent face identification task, whilst reporting the features of the Navon stimuli impaired performance. Using a face composite task, which is assumed to require featural processing, Weston and Perfect (2005) showed the complementary pattern: Featural responding to Navon letters speeded performance. However, both studies used Navon stimuli with global precedence, in which the overall configuration is easier to report than the features. Here we replicate the two studies above, whilst manipulating the precedence (global or featural) of the letter stimuli in the orientation task. Both studies replicated the previously reported findings with global precedence stimuli, but showed the reverse pattern with local precedence stimuli. These data raise important questions as to what is transferred between the Navon orientation task and the face-processing tasks that follow.

Keywords: Face recognition; Processing orientation; Global processing; Featural processing.

There is a broad range of evidence to suggest that familiar faces are processed configurally, such that processing of one facial feature is influenced by its configural relationship with other features (Tanaka & Farah, 1993). Generally, evidence suggests that configural processing is associated with superior recognition performance. For instance, face recognition is particularly sensitive to the effects of inversion, an effect that is

attributed to the disruption of configural relationships between features in an upside-down face (Rhodes, Brake, Taylor & Tan, 1989). Likewise, the superiority in face recognition for members of one's own racial group over other racial groups has been attributed to greater reliance on configural processing (Rhodes et al., 1989). Finally, composite face recognition, in which the top-half of one face is paired with the bottom-half of a

Correspondence should be addressed to T. J. Perfect, School of Psychology, University of Plymouth, Plymouth PL4 8AA, UK.
E-mail: tperfect@plymouth.ac.uk

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different face, is impaired when the halves align, indicating a configural whole, rather than when they are misaligned (Young, Hellawell, & Hay, 1987), an effect that is greater for own-race faces than for other-race faces (Michel, Rossion, Han, Churg, & Caldara, 2006).

In the eyewitness memory domain there is also an interest in configural face processing. It has been shown that providing a verbal description prior to making a line-up identification can impair performance, an effect known as verbal overshadowing (Schooler & Engstler-Schooler, 1990). Three pieces of evidence have been used to argue that this effect is due to a shift towards featural processing at test. Verbal overshadowing effects occur if the object described is not the target person (Dodson, Johnson, & Schooler, 1997; Westerman & Larsen, 1997), for upright, but not inverted, faces and for own-race, but not other-race, faces (Fallshore & Schooler, 1995).

Macrae and Lewis (2002) argued that if verbalization reduces eyewitness performance because of a shift towards featural processing, then a shift towards configural processing should improve face recognition. Consequently they replaced the verbalization condition of a verbal overshadowing paradigm with global or local responding to Navon stimuli (Navon, 1977). These stimuli (see top panel of Figure 1) are large letter shapes constructed from smaller letter features. Participants can respond to the global shape of such stimuli (global processing) or the smaller letters that make up the shape (local processing), whilst keeping the physical stimuli identical. In their study, participants either acted as a control group, or engaged in either global or local processing for 10 minutes between seeing a video and attempting a line-up. As predicted, the shift towards featural processing impaired recognition performance (30% correct), relative to control (60% correct) in line with the work on verbal overshadowing. Global processing led to a significant improvement in recognition performance (83% correct) as predicted. This pattern has subsequently been replicated (Perfect, 2003; Perfect, Dennis, & Snell, 2007), though others have failed to find such an effect (Lawson, 2007).

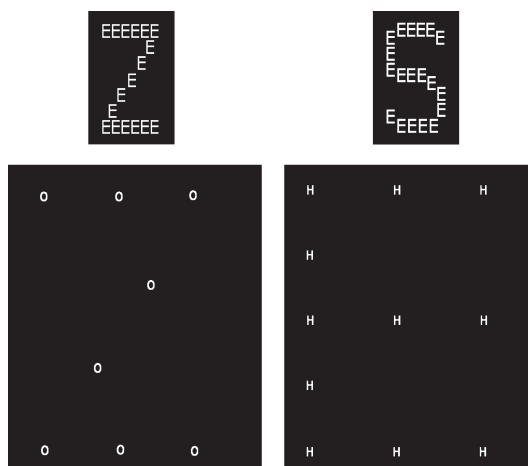


Figure 1. Example Navon stimuli with global precedence (top panel) or local precedence (bottom panel) used in both experiments.

One possible explanation for the effect is that global processing somehow has an overall positive effect and local processing a negative effect through a nonmemorial process such as motivation, carefulness, or willingness to respond. To rule out such an explanation, a face recognition task that relies upon featural processing is needed. Weston and Perfect (2005) took this approach using Young et al.'s (1987) composite task. In the composite task the top half of one face is aligned with the bottom half of another face, and the participant is required to identify one half of the composite face. Young et al. found that when such composites were aligned, creating the appearance of a normal face, participants were slower to identify a face-half than when the same two face-halves were misaligned, giving no impression of a normal face. They attributed this slowing in the aligned condition to the misleading configural information produced by the aligned composites. Consequently, the composite task is one for which prior global processing should hinder, and prior local processing should help.

Weston and Perfect (2005) tested this prediction by having participants report global or local features of Navon stimuli in the interval between face encoding and a forced-choice test using

face-composites. No effects were observed with the accuracy of decisions, but the latency to identify face-halves was related to the orientation condition. Orienting towards local features of Navon stimuli reliably speeded face-half recognition. Thus, superior performance on this task was associated with local processing, rather than global processing, as had been predicted.

Nonetheless, the studies to date have used global-precedence Navon stimuli, for which it is easier to report the overall global letter shape than the features that make up that shape. Consequently, processing orientation (global/local) has been confounded with precedence, since in previous studies, global orientation has meant responding to the dominant property of the stimulus, whilst local orientation has meant responding to the non-dominant property (and so presumably inhibiting response to the dominant aspect). However, precedence need not be confounded with processing orientation. In the present studies we adopted the use of local-precedence Navon stimuli (Parmentier & Andres, 2003). The expectation was that if global or local processing is crucial, then we will replicate the previous findings of global advantage with face recognition (Experiment 1) and local advantage for composite recognition (Experiment 2), irrespective of the precedence of the Navon stimuli. However, if the precedence is crucial in producing the previous effects, one might expect that the effects might be restricted to the use of global-precedence Navon stimuli, with no effect for local-precedence Navon, or perhaps even a reversed effect.

EXPERIMENT 1

Method

Participants

A total of 80 undergraduates from the University of Plymouth participated in the study, either for partial course credit, or for £3 payment. Their mean age was 19.5 years ($SD = 3.5$ years). No other demographic data were recorded.

Materials

This study utilized the video and line-up used by Macrae and Lewis (2002). Participants saw 30 Navon stimuli for 5 s each and verbally reported either the global shapes, or the local letters, depending upon the orienting condition they were allocated to. The Navon stimuli (see Figure 1) were taken from Parmentier and Andres (2003) and were either global precedence (85 mm high \times 55 mm wide) or local precedence (115 mm high \times 95 mm wide), printed in white on a black background.¹

Procedure

Participants were tested individually and were asked to carefully watch a brief video clip previously used by Macrae and Lewis (2002). Participants were randomly allocated to one of four experimental conditions, in which they saw either global- or local-precedence Navon stimuli, and were asked to verbally report either the local features or the global letter shape for each of 30 items, presented at 5-s intervals.

Following the Navon task all participants saw the same 8-person target-present simultaneous line-up and either made a line-up choice or indicated that they thought the perpetrator was not in the line-up.

Results and discussion

Because the outcome of the line-up was binary (correct, incorrect), a logistic regression of response accuracy was undertaken, with precedence, response orientation, and their interaction as predictors, using deviation coding. There was no main effect of precedence, $W(1) = 3.49$, $p < .07$, or response orientation, $W(1) = 1.59$, $p < .21$, but there was a significant interaction between the two, $W(1) = 4.95$, $p < .05$. The nature of this interaction is shown in Figure 2.

In the global-precedence Navon condition, superior performance followed global responding (odds ratio = 3.45). However, for the

¹ The full set of Navon materials used in this study is available from the first author.

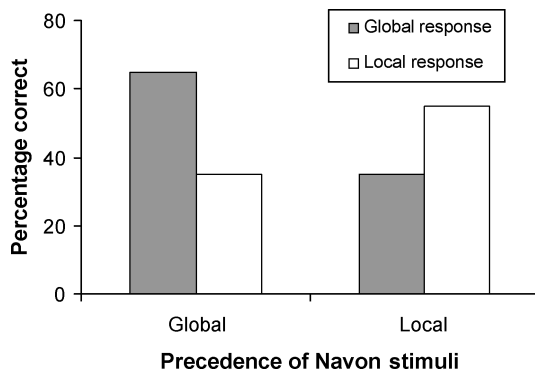


Figure 2. Experiment 1: Percentage of correct responses to the line-up task following global or local processing to global-precedence or local-precedence Navon stimuli.

local-precedence Navon condition, superior performance was seen following local responding (odds ratio = 2.26). That is, in both cases, superior performance was seen in the condition consistent with the precedence of the stimuli.

Before speculating upon the causal mechanism behind these data we report a second experiment, in which a different outcome was expected for the global-precedence Navon condition. Recall that Weston and Perfect (2005) showed that recognition of face-halves seen in composite form (Young et al., 1987) is speeded by prior local processing. If this effect also reverses with the precedence of the Navon stimuli, then one would expect superior performance to be associated with local responding to global-precedence stimuli (as before) but global responding to local-precedence stimuli (the opposite pattern).

EXPERIMENT 2

Method

Participants

A total of 125 members of the University of Plymouth community took part in this experiment for either payment or partial course credit. All participants were either undergraduates or graduates of the university. Their mean age was 20.44 years ($SD = 4.37$).

Stimuli

The encoding and test face stimuli were greyscale photographs of 52 males. All stimuli were taken from the University of Stirling Psychology Department Psychological Image Collection (images were downloaded from the Stirling University face database. Retrieved October 24, 2002, from <http://pics.psych.stir.ac.uk>). All shoulders were removed from the photographs to avoid any clothing biases, and the background of each face was set to white. In order to create the facial composites all facial stimuli were divided into two halves; this was achieved by drawing a horizontal line across the bridge of the nose on each face and cutting the face in half at that point. It was essential that this horizontal line was at the same point on each face to ensure that when two different halves were aligned they created the illusion of a whole face. The stimulus set was divided into 12 test stimuli and 36 distractor stimuli. One further test stimulus was used for the practice trial along with a further three distractors. At test, one half of the target item previously presented was shown and was mixed randomly with the distractor face stimuli to create facial composites. The Navon stimuli used in Experiment 1 were retained.

Procedure

Participants were tested individually. They were told that there were three stages to each of 12 trials. The first stage was to remember a whole face presented to them on the computer screen for 2 s. The second stage was the Navon condition, which lasted for 60 s. Participants were presented with 30 local- or global-precedence Navon letters each displayed on the screen for 2 s, and they responded to either the local or global properties as in Experiment 1.

Immediately following the Navon task, participants were presented with two composite faces in the form of a two-alternative forced-choice test, as in Weston and Perfect (2005). The participants' task was to identify, by means of two labelled keys, which of the composite faces contained one half of the face that they saw in the study phase for that trial. The particular half to be judged was cued by means of a question: "Whose eyes have you seen before?" cued a judgement about the

top-half of the composites, whilst “Whose *mouth* have you seen before?” cued a judgement about the bottom-half of the composites. On each trial one composite was made up of one half from the test stimuli (“old” half) and one other distractor half. The other composite was made up of two distractor halves. The position of the “old” half face position was randomized with respect to the two faces. On half of the trials face-halves were presented aligned, and on the other half they were misaligned, with the set being aligned being counterbalanced across participants.

Prior to the experiment each participant worked through a practice trial, in order to remove any uncertainties that they may have had about the nature of the task. For the experiment proper, participants completed a total of 12 test trials. Test faces remained on the screen until participants made their choice. Participants were instructed to respond as quickly and as accurately as possible. No face or face-half appeared on more than one trial. On each trial, the participant’s accuracy was recorded along with their reaction time to respond.

Results and discussion

Preliminary inspection of the data revealed 4 outliers. A total of 2 participants achieved below-chance levels of performance (both on 33% on a two-choice test) compared to mean performance of 90%. Their data were discarded. We also dropped 2 participants who had mean reaction times more than 2 standard deviations in excess of the group mean.

The proportion of correct responses to the face stimuli was subject to a 2 (alignment: aligned vs. misaligned) \times 2 (processing orientation: global vs. local) \times 2 (Navon stimuli: global versus local precedence) analysis of variance (ANOVA). However, performance was close to ceiling (mean .90, SD .10), and there were no reliable main effects or interactions between the factors on the accuracy data, $F < 1$ in all cases). With one key exception, the equivalent analysis on response latencies also failed to show any significant main effects or interactions ($F < 1.83$, $p > .18$, in all cases). The one exception was an interaction between processing

orientation and Navon stimuli, $F(1, 117) = 9.17$, $p < .003$, $MSE = 2,033,710$. The nature of this interaction is illustrated in Figure 3 and shows the mirror image of the pattern reported in Experiment 1. Tests of the simple main effects revealed that for global-precedence Navon stimuli, faster responses are associated with local responding, $F(1, 117) = 4.13$, $p < .05$, whilst for the local-precedence Navon stimuli, faster responding is associated with global responding, $F(1, 117) = 5.06$, $p < .03$.

These data are therefore in line with results of previous research. Using the global-precedence stimuli like Weston and Perfect (2005) shows the same beneficial effect of prior local processing. However, using local-precedence Navon stimuli gives entirely the reverse pattern, as in Experiment 1. Thus, whilst the data from the global-precedence Navon stimuli fit the previous transfer-appropriate processing account (Macrae & Lewis, 2002; Weston & Perfect, 2005), the data from the local-precedence Navon stimuli do not.

GENERAL DISCUSSION

The data from the two experiments are entirely consistent. Experiment 1 used a face recognition task that was hypothesized to rely more on holistic processing, predicted to be aided by global

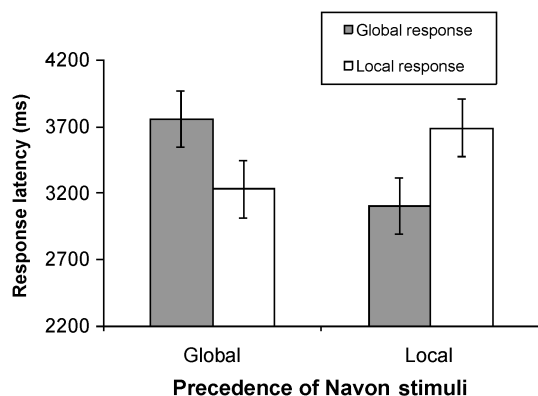


Figure 3. Experiment 2: Mean response latency for correct responses on the forced-choice face-composite task following global or local processing to global-precedence or local-precedence Navon stimuli. (Error bars represent the standard errors.)

processing. Experiment 2 used a composite task predicted to be aided by featural orientation. The data from the global-precedence conditions in both experiments replicated previous findings and are consistent with the processing transfer account. In contrast, when the local-precedence Navon stimuli were used, both experiments showed a reverse pattern contradicting the processing transfer account. These effects are mirror images, but what do they reflect?

These data are not compatible with the assumption that a local or global processing orientation transfers from the Navon task to the face recognition tasks. This transfer-inappropriate-processing account of verbal overshadowing (Schooler, 2002), adopted by Macrae and Lewis (2002) to explain their data, is not compatible with the reversal of the effects with local-precedence stimuli. It does not appear to be local or global processing per se that is transferred from the orienting task to the face tasks. Rather, it is some other attribute of the Navon stimuli that reverses between the global- and local-precedence stimuli.

One obvious attribute that varies between local-precedence and global-precedence Navon stimuli is their physical size. The local-precedence stimuli occupy a larger total area and are more sparsely represented. Thus, one potential explanation for the effects is the area over which participants must distribute their attention in order to make a response. However, an account based upon distribution of attention is only partially successful. One could argue that for global-precedence Navon stimuli, the global size of the letter to which the participants attend corresponds to an area over which a face recognition judgement must be made, whilst the featural response requires attention to too narrow a spatial area. Conversely, for the composite task the featural focus provides the right level of tightness of focus to support the composite task, whilst the global responses leave attention too widely distributed. However, this line of argument breaks down when trying to account for the composite task data with the local-precedence Navon stimuli. A distribution of attention account cannot explain why attending

to the global features of the largest stimuli aids performance on a judgement of half a face.

Another possibility is that it is not global or featural processing per se that is crucial, but resisting the interfering effect of the dominant response. Under this view, face recognition is not aided by shifting toward global processing as much as resisting featural processing, whilst performance on the composite task is aided by resisting the global processing. After all, what has been neglected to date in this literature is that Navon stimuli have Stroop-like properties, in which two potential responses compete for a response. To date, discussion has centred on what participants respond to, not what they inhibit (Macrae & Lewis, 2002; Perfect, 2003). An inhibition-based account copes well with the precedence effect in the face recognition task, since for global-precedence Navon, global shape will interfere with the local features more than the reverse. Thus, in order to succeed on a global-precedence Navon task, featural responding requires inhibition of the global level, but global responding requires no inhibition of local processing. For the local-precedence stimuli the reverse is true; global responses require inhibition of featural information, whilst local responses need no inhibition. Consequently for the subsequent face-recognition test, in which a response can be made either from global or local information, two Navon conditions carry forward inhibition, namely those requiring responses to the nondominant feature. If this inhibition carries over into the face recognition task, then poorer performance would result in these two conditions: This is exactly what was found.

Unfortunately this inhibition account breaks also down as an explanation of the composite task, in particular the relative advantage that follows global responding to local-precedence stimuli. To succeed on the composite task one needs to inhibit global processing. Consequently for the local-precedence stimuli, performance should be slower for global responding than for local responding, since the former requires no inhibition of global processing. In fact, the data show the reverse.

However, there is another explanation of the present effects, which builds upon the notion of

asymmetric inhibition in the two Navon conditions, and which can account for the entire pattern. Critically, it makes no reference to global or local processing. The starting point for this account is that responding to the nondominant aspect of the Navon stimuli requires transfer from automatic to controlled responding. Thus, responding locally to global-precedence stimuli, or globally to local-precedence stimuli, requires controlled or analytic processing. Conversely, responding to the dominant aspect of Navon stimuli requires no such shift and thus favours automatic processing. Now consider the two face recognition tasks. The face identification task involves no process of inhibitory control: The participant can recognize the target from either global matching of the face or featural identification. If controlled performance is carried forward from the conditions requiring nondominant responding to Navon stimuli, this may impact negatively on face recognition. This prediction is supported by the data showing poorer performance following nondominant Navon responding, for both kinds of Navon stimuli. This notion that a controlled recognition judgement might be less accurate than an automatic one is also consistent with data from self-report of strategy use by eyewitnesses. Dunning and Stern (1994) showed that those witnesses who report using automatic strategies are more accurate in their identifications than those who reported controlled, comparative judgements.

In contrast, success on the composite task does require a controlled or analytic response: The participants have to respond only to one half of the face and must inhibit their response based on the misleading composite. Thus, those participants who are oriented towards controlled processing should now show superior performance, exactly the opposite of the face-processing task. This is what was found.

This rather speculative account suggests that it is the Stroop-like properties of the Navon stimuli that produce the effects seen in the literature, rather than their local or global properties per se. Whilst further research is necessary to

establish the robustness of this account, it does offer an intriguing perspective on a troublesome aspect of the processing-bias literature. The most obvious corollary of the present findings is that the nature of the Navon stimuli could drive whether or not any effects are found in the subsequent face recognition task. The original Macrae and Lewis (2002) study provides no detail as to the construction of the Navon stimuli, and subsequent studies do not provide much information either. Given this lack of information, researchers have tended to create the Navon stimuli themselves, and this may lead to discrepancies between studies. Failures to replicate the Navon bias effect (e.g., Lawson, 2007), may stem from the use of Navon stimuli that do not give a powerful global-precedence effect. The present data suggest that in future researchers need to be more explicit about the nature of the Navon stimuli that they use. This perspective also has the potential to explain the recent demonstration by Lewis (2006) that completing cryptic crosswords, but not standard crosswords, impairs subsequent line-up performance. Perhaps cryptic crosswords also engender controlled rather than automatic processing.

A final speculation also flows from the present work. Macrae and Lewis's (2002) original study of the biasing effect of orientation to Navon letters was a test of the processing-bias account of verbal overshadowing. If the present pattern holds in future studies, then it may be that the verbal-overshadowing effect itself could be recast as an effect of transferring from automatic to controlled processing, rather than from global to featural processing (Schooler, 2002). In this view, verbal descriptions can hinder subsequent face recognition not because they cause interference (Meissner, 2002), or because they cause a shift away from configural processing (Schooler, 2002), but because they cause a shift away from automatic processing.

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