The distinctiveness effect reverses when using well-controlled distractors

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The distinctiveness effect in memory holds that distinctive items (e.g., unusual objects, infrequent words, or atypical faces) have a recognition advantage over typical items (e.g., Geraci & Rajaram, 2002; Schmidt, 1991; Valentine, 1991). The recognition advantage is usually operationalized as a higher hit rate and lower false alarm rate for distinctive items. Although the effect has been replicated numerous times in various domains, the conclusion that distinctive items are remembered *better* than typical items seems at odds with other findings in cognitive psychology. In particular, typicality effects, such as the recognition advantage for prototypical colours (Lucy & Shweder, 1979) and the improved discrimination of own-race faces (e.g., Walker & Tanaka, 2003), suggest that we have better mental representations for frequently encountered, typical items.

A key factor that is often overlooked in studies on distinctiveness is the role of foils, or distractors. In face recognition experiments, subjects study a set of target faces and later try to pick the target faces from among distractor faces, either in a forced-choice or old/new paradigm. Although experimenters usually select distractors randomly, this does not guarantee an equitable comparison between the two types of faces. The central distribution of face space (see Valentine, 1991) actually predicts a systematic relationship between the distinctiveness of a face and its overall similarity to randomly chosen distractors. A simple geometric analysis shows that random distractors will be statistically more similar to typical faces (located more centrally in face space) than to distinctive faces (located more peripherally). This asymmetry implies that distinctive faces will be overall more distinguishable from random distractors, and therefore more recognizable when pitted against them.

We propose that the well-reported distinctiveness advantage in face recognition is primarily due to this asymmetry. We further propose that if the asymmetry is eliminated, typical faces should be recognized more accurately than distinctive faces, consistent with other typicality effects. To this aim, we describe two studies that measure the accuracy of face

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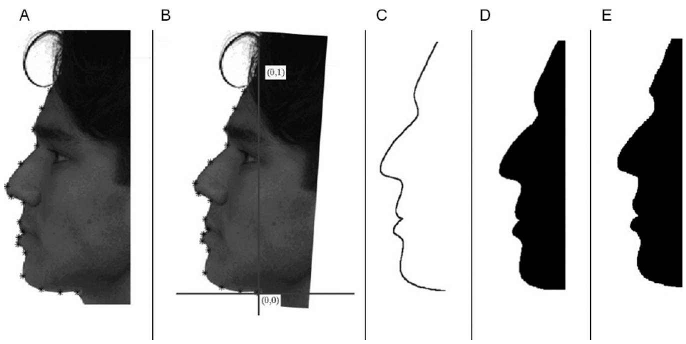

Figure 1. Steps in the parameterization of silhouette. The original greyscale profile image with landmark points (A); normalized (B); splines between adjacent points create a smooth contour (C) that is filled in (D). The original image reduced to two tones shown for comparison (E).

recognition. The stimuli for these studies are parameterized face silhouettes (see Figure 1) that have been previously validated as psychologically legitimate face stimuli (Davidenko, 2004). The use of a fully parameterized face space allows us to create precisely controlled face stimuli and examine the role of distractor choice.

STUDY 1: REPLICATION OF THE STANDARD DISTINCTIVENESS EFFECT

Twelve Stanford undergraduates completed an old/new task with parameterized face silhouettes. Using Matlab, we constructed 210 silhouettes by sampling randomly from a multinormally distributed silhouette face space derived from 48 actual face profiles (see Davidenko, 2004). Silhouettes were designated as typical or distinctive based on their distance in face space from the overall norm (typical silhouettes being closer to the norm). Of the 105 typical silhouettes, 70 were randomly designated as targets and 35 as distractors, and likewise for the 105 distinctive silhouettes.

Participants completed 35 trials in which they observed a sequence of four "training" silhouettes, followed by an 8-s retention interval. They then observed a sequence of four "test" silhouettes (two targets and two distractors, in random order) which they judged as "old" or "new". Each response was coded as a hit, miss, false alarm, or correct rejection. Consistent with previous studies using front-view face images (e.g., Shepherd, Gibling, & Ellis, 1991), distinctive silhouettes yielded significantly higher hit rates (0.63 vs. 0.54; two-tailed paired t-test $=2.78$, $p<.05$) and significantly lower false alarm rates (0.21 vs. 0.33; two-tailed paired t-test $=2.57$, $p<.05$) than typical silhouettes. We conclude that the classic distinctiveness effect replicates with face silhouettes.

As mentioned above, the centrally dense distribution of faces in face space predicts that randomly chosen distractors will be on the whole more similar to distinctive faces than to typical faces. To test whether a recognition advantage for distinctive faces persists in the absence of this asymmetry, we conducted a study that used equally spaced distractors for every target silhouette.

STUDY 2: DECONFOUNDING DISTINCTIVENESS AND ISOLATION FROM DISTRACTORS

Sixteen Stanford undergraduates participated in a short-delay recognition task using a three-alternative forced-choice paradigm. Using Matlab, we constructed 50 typical and 50 distinctive target silhouettes in the same way as in Study 1. Two distractors were constructed specifically for each target silhouette by translating the target silhouette a small distance in silhouette face space. The magnitude of these translations was kept constant for all targets, while the direction was allowed to vary randomly.

Participants completed 100 trials in which they observed a target silhouette for 2.5 s, a random line mask for 2 s, and a test set of three silhouettes from which they attempted to identify the target. Performance was coded as percentage correct identification of target silhouettes. Mean performance across participants was 61% for typical silhouettes and 56% for distinctive silhouettes, revealing a significant *disadvantage* for distinctive silhouettes (two-tailed paired t-test $= 2.20$, $p < .05$). We thus report a "reverse distinctiveness effect", whereby typical face silhouettes are recognized more accurately than distinctive face silhouettes.

In a variation of this study, we equated the sizes of the face space regions corresponding to typical and distinctive silhouettes to avoid the possibility of preferential online learning of typical silhouettes during the experiment. The results were consistent with Study 2, again revealing a recognition disadvantage for distinctive silhouettes.

Together, these studies provide evidence that prior experience with central regions of face space (corresponding to typical faces) improves our ability to discriminate and represent these faces in short-term memory. The choice of distractors in recognition tasks, which is often overlooked and rarely manipulated, clearly influences performance in recognition tasks. By constructing distractors that were equally spaced from typical and distinctive targets, we were able to more fairly compare performance on the two types of faces. Consistent with other typicality effects, we found that typical face silhouettes are remembered more accurately than distinctive faces silhouettes. We suggest that this "reverse distinctiveness effect" will generalize, not only to standard front-view face stimuli, but also to other object categories with centrally dense distributions.

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Velocity cues improve visual search and multiple object tracking

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Early stages of visual processing are thought to rapidly extract a number of basic perceptual attributes from a visual stimulus, including object bound-

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