UC Merced
Proceedings of the Annual Meeting of the Cognitive Science Society

Title
Naming and remembering atypically colored objects: support for the processing time account for a secondary distinctiveness effect

Permalink
https://escholarship.org/uc/item/15c711m6

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 36(36)

ISSN
1069-7977

Authors
Westerbeek, Hans
Van Amelsvoort, Marije
Maes, Alfons
et al.

Publication Date
2014

Peer reviewed

eScholarship.org Powered by the California Digital Library
University of California

Naming and remembering atypically colored objects: Support for the processing time account for a secondary distinctiveness effect

Hans Westerbeek (h.g.w.westerbeek@tilburguniversity.edu)
Marije van Amelsvoort (m.a.a.vanamelsvoort@tilburguniversity.edu)
Alfons Maes (maes@tilburguniversity.edu)
Marc Swerts (m.g.j.swerts@tilburguniversity.edu)
Tilburg center for Cognition and Communication (TiCC), Tilburg University, The Netherlands

Abstract

The secondary distinctiveness effect is the effect that stimuli that are unusual or different from stored knowledge are remembered better than common stimuli. We investigate the processing time explanation for this effect, i.e., that distinctive stimuli receive more attention and thus more processing time during encoding, by combining methodology from object recognition with memory tasks. Participants in our experiment name common and distinctive items (typically and atypically colored objects), and then memory is tested. Our results replicate the secondary distinctiveness effect, as recognition scores are higher for atypically colored objects than for typical ones. Crucially, analyses of response times in the naming task show that atypically colored objects are processed significantly slower than typical ones. We take these findings as providing support for the processing time hypothesis for the secondary distinctiveness effect.

Keywords: Memory, secondary distinctiveness, color, processing time, object recognition

Introduction

Items that are unusual or distinctive are remembered better than common items (e.g., Hunt & Worthen, 2006). Over the years, this distinctiveness effect has been replicated many times, and remains a field of investigation in current experimental psychology (e.g., Michelon, Snyder, Buckner, McAvoy, & Zacks, 2003; McDaniel & Bugg, 2008). The distinctiveness effect is often divided into two types (Schmidt, 1991). Primary distinctiveness is the effect that items that are different from the other items presented in the same (experimental) setting are remembered better (e.g., because they belong to a different semantic category; Schmidt, 1985). For example, a dog in a list of fruits is recalled better than an orange in that same list.

Secondary distinctiveness is the effect that items that are felt as being unusual as compared to general knowledge are more memorable than common items. For example, a picture of something that is unusual in reality (like a green lion) is more memorable than a picture of something that is normal. Because such secondary distinctive items are regarded as 'strange', the secondary distinctiveness effect is sometimes called a 'bizarreness' effect (e.g., McDaniel & Bugg, 2008).

This effect has been replicated using a wide variety of research designs and stimulus materials, in order to explore the conditions under which it occurs. Research designs for example vary in how memory is tested (e.g., Graesser, Woll, Kowalski, & Smith, 1980), whether stimuli are learned intentionally or implicitly (e.g., Nicolas & Marchal, 1998), and in the time span between learning and testing (e.g., O'Brien & Wolford, 1982; McDaniel & Einstein, 1986). With regard to stimulus materials, a notable distinction can be made between studies that present participants with sentences describing situations that are secondary distinctive (e.g., "The goldfish was eating out of the bowl on the sofa"; McDaniel and Einstein, 1986), and studies that use pictures of objects that are different from stored knowledge (e.g., a dog with a watering can as a head, or a candle with wicks on its sides; Michelon et al., 2003; Gounden & Nicolas, 2012).

While significant advances have been made in understanding the boundary conditions of the secondary distinctiveness effect, scholars have reached little consensus on the various explanations for the effect. The (not mutually exclusive) accounts can be roughly distinguished into those that propose that secondary distinctive stimuli are *encoded* differently than common ones (e.g., Kline & Groninger, 1991), and accounts stating that secondary distinctive stimuli contain more (distinctive) cues that can be helpful in *retrieval* (e.g., McDaniel & Einstein, 1986).

One intuitive encoding-based explanation for the secondary distinctiveness effect is the *processing time hypothesis* (e.g., Kline & Groninger, 1991; Gounden & Nicolas, 2012). According to this account, secondary distinctive items attract more attention than common ones during learning, and as a consequence more time is spent on the distinctive items, leading to superior memory for these stimuli.

However, studies have often been unable to provide empirical data to support the processing time hypothesis. In these studies, presentation time of items during encoding is manipulated. For instance, McDaniel and Einstein (1986) investigated this hypothesis by presenting common and secondary distinctive sentences either for seven or for fourteen seconds, and did not find that presentation time modulated the secondary distinctiveness effect in a recognition task. Gounden and Nicolas (2012) presented drawings of normal or abnormal objects for a half, one, or three seconds. Similar to the aforementioned study, processing time did not interact with the secondary distinctiveness effect. That is, a secondary distinctiveness effect was obtained, but it was not modulated by presentation time. Kline and Groninger (1991) report results that do suggest that the secondary distinctiveness effect can be modulated by processing time, but the direction of the effect is unclear: secondary distinctive items were not found to be processed longer than common items.

The aforementioned studies manipulated *presentation time* to investigate a potential modulating role of *processing time* on the secondary distinctiveness effect. However, presentation time is not necessarily the same as processing time. In the current research, it is reasoned that manipulations of presentation time make it difficult to ascribe modulations of a secondary distinctiveness effect to differences in processing time. This is not only because presentation time and processing time are not necessarily the same concepts, but also because one cannot know how quickly common and distinctive items are processed. Also, processing time is likely to vastly differ between different kinds of stimuli. Presentation times in experiments can be too short to obtain the 'necessary' encoding effect for secondary distinctive items. They can also be too long, such that distinctive items that are potentially harder to process get sufficient processing time anyway, nullifying a potential modulation of the memory effect.

A solution is to consider secondary distinctive items that are known to require more processing time than common items. Studies in the field of object recognition provide evidence that pictures of secondary distinctive objects require more time to be processed. In object recognition, it is well established that pictures of objects that have an atypical color (e.g., red banana) are less quickly processed (i.e., recognized and named) than pictures of typically colored objects (e.g., Naor-Raz, Tarr, & Kesten, 2003; Tanaka, Wayward, & Williams, 2001; Therriault, Yaxley, & Zwaan, 2009). Objects that have an atypical color are secondary distinctive: they are unusual compared to stored knowledge, which contains information about the default color of an object (Naor-Raz et al., 2003). So, object recognition studies show that processing atypically colored objects takes more time, but we do not know whether this influences memory.

The current experiment

We want to investigate the processing time hypothesis as an explanation for the secondary distinctiveness effect, taking an interdisciplinary approach by combining methodology from object recognition with procedures from memory research. We administer a naming task with pictures of typically and atypically colored objects as encoding task, so we can measure processing time (i.e., naming latency) for common and secondary distinctive items. Consecutively, memory is tested in old/new recognition tests. In that way, we can investigate whether a difference in processing time is associated with better memory for these items.

Experiment

In this experiment, we asked participants to name typically and atypically colored everyday objects. As the participants were not instructed about the successive memory tests, our paradigm entails incidental learning. Directly after naming, the memory task − an old/new recognition task − was administered to test whether incidental learning was successful. Secondary distinctiveness effects are often found when there is a sufficient delay between encoding and testing (e.g., McDaniel & Einstein, 1986; Michelon et al., 2003), and therefore the memory task was re-administered two weeks later.

Method

Participants Forty undergraduate students (all speakers of Dutch, eight men and thirty-two women, median age 22 years) participated for course credit. They were not instructed about the fact that their memory would be tested. None of the participants were color blind, which was assessed in a test after the experiment.

Materials Seventy-six everyday objects were selected on the basis of stimuli used in object recognition studies (e.g., Therriault et al., 2009). These were all color-diagnostic objects (i.e., objects that have one or a few typical colors associated with them). For each object a high quality photo was selected and edited, such that the object was seen on a plain white background. For the atypically colored versions, further photo editing was done to change the objects' color. Atypical colors were determined by rotating colors across the various objects, such that the number of objects in each color (red, blue, yellow, orange, green, brown, pink) was the same in both typicality conditions. Figure 1 presents some examples of objects in typical and atypical colors, as we used them in the experiment.

The seventy-six objects were equally distributed over two lists. In each list of thirty-eight objects, half of the objects was typically colored, and the other half was atypical. We ensured that an object never appeared in more than one color within each list. Of both lists, as second version was assembled in which color typicality was reversed: objects that were typically colored in one version were atypical in the other and vice versa. This resulted in two versions of two lists of objects.

The lists were matched for color frequency, whether the objects are easily named (nameability), whether the typically colored pictures matched mental prototypes (prototypicality), how frequent the object's name is in the language (Dutch), the length of the name in syllables, and the lu8minosity (i.e., brightness) of the pictures. We also made sure

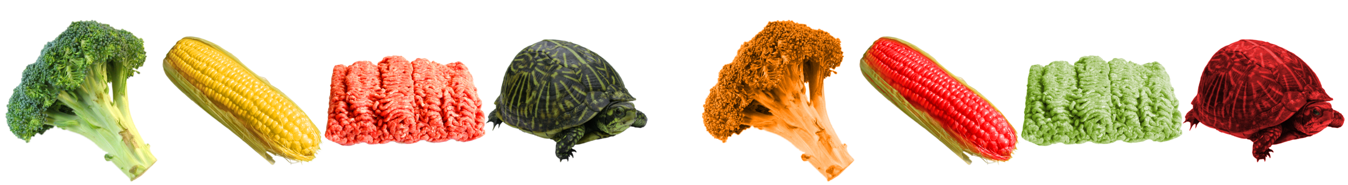

Figure 1: Some examples of stimulus materials used in the experiment, in typical colors (left) and in atypical colors (right).

that luminosity was not different for typical and atypical objects within each list. Nameability and prototypicality of the typically colored objects were determined by pretests. Name frequencies were assessed using an on-line corpus (Keuleers, Brysbaert, & New, 2010). Luminosity was measured using MATLAB.

Procedure The experiment was performed in a dimly lit sound proof cabin, to minimize distraction. Participants were randomly assigned to one of the stimulus lists. They were instructed that they would get to see a number of pictures on a computer screen, and that they had to name the depicted objects as fast as possible. The instructions did not mention that memory would be tested after the naming task. The objects appeared in a random order, one by one. The presentation time for each object was exactly 3000 ms, preceded by a fixation cross (800 ms) and followed by a blank screen (1000 ms). The first three items were filler objects, after which the thirty-eight stimulus objects were presented in a random order.

Immediately after the naming task, the participants had to perform a second task. They were instructed that the photos from the first task would be shown once again, but that new objects would be mixed in. Participants had to say out loud (and as quickly as possible) whether each object was part of the naming task ("yes") or not ("no"). The new objects were the objects from the list that the participant did not name. The old and new objects were presented in a random order.

The participants were asked to return to the lab about two weeks later, but they were not instructed about the purpose of this second meeting. All participants returned to the lab and performed the old/new recognition task again. Due to practical constraints, the delay between the tasks ranged from 11 to 18 days across participants (the median delay was 15 days, most participants returned after 14, 15 or 16 days). After this task, color blindness was assessed.

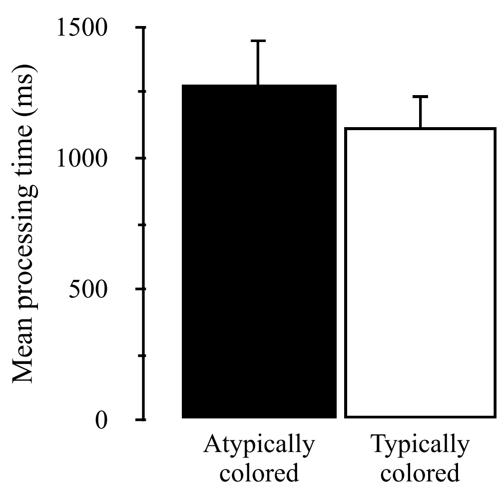

Figure 2: Mean processing times (in milliseconds) in the naming task, for atypically and typically colored objects. Error bars represent standard deviations.

Responses were recorded with a head-mounted microphone. Stimulus randomization, timing, and voice recording were administered using E-Prime (Schneider, Eschman, & Zuccolotto, 2002). Reaction times were measured by analyzing the audio recordings in Praat (Boersma & Weenink, 2012).

Research design and statistical analysis For the naming task, we compared response times for typically and atypically colored objects in a within-participants design. For the recognition task, we compared hits, false alarms and recognition scores in a similar within-participants design. Response times and recognition data were analyzed using repeated measures ANOVAs, both on participants means (F_1) as on item means (F_2).

Results

Naming task Despite the pretests, five of the seventy-six objects (blackberry, celery, pickle, red cabbage, sprout) yielded disproportionally high numbers of incorrect responses or non-responses, and were excluded from all analyses (especially the atypically colored versions of these objects turned out to be problematic). Response times for incorrect responses were also discarded. An outlier analysis on response times for correctly named objects, in which we removed response times that were faster than 500 ms or longer than 2500 ms, resulted in discarding of 0.3 percent of the data.

Analysis of the processing time in the naming task, shown in Figure 2, revealed a main effect of color typicality: $F_1(1,39)=92.29$, $p<.001$, $\eta_p^2=0.703$; $F_2(1,70)=65.97$, $p<.001$, $\eta_p^2=0.485$. Typically colored objects were named significantly faster (M=1119 ms, SD=119 ms) than atypically colored ones (M=1282 ms, SD=167 ms).

Recognition tasks As is common practice in analyzing responses for old/new tasks, we corrected for response bias by calculating a recognition score (e.g., McDaniel & Einstein, 1986). This recognition score corrects the percentage of hits (i.e., the participant saying that an object was seen when it actually was) for the percentage of false alarms (i.e., the participant saying that an object was seen while it actually was not), and is calculated as $(P_{hit}-P_{false\ alarm})/(1-P_{false\ alarm})$.

Results of the immediate recognition task showed no effects of color typicality on hits, false alarms, and on recognition scores; all p's > .07. Performance was near perfect as hit rates and recognition scores were both well above 95 percent.

Table 1: Results of the delayed recognition task, in percentages, collapsed over participants. Standard deviations are in parentheses.

	Typically colored objects	Atypically colored objects
Hits	67.5 (16.6)	82.8 (10.2)
False Alarms	20.9 (16.3)	26.4 (15.4)
Recognition Score	59.8 (18.6)	76.5 (14.7)

Results of the delayed recognition task are shown in Table 1. Analyses of hit rates revealed a main effect of color typicality, such that there were significantly more hits for atypically colored objects: $F_1(1,39)=35.85$, $p<.001$, $\eta_p^2=0.479$; $F_2(1,70)=27.89$, $p<.001$ $\eta_p^2=0.285$. A weaker, marginally significant effect was found for false alarms: $F_1(1,39)=4.27$, $p=.046$, $\eta_p^2=0.099$; $F_2(1,70)=3.46$, $p=.07$. Importantly, recognition scores were higher for atypically colored objects than for typically colored ones: $F_1(1,39)=27.17$, $p<.001$, $\eta_p^2=0.411$; $F_2(1,70)=20.24$, $p<.001$, $\eta_p^2=0.224$[1].

Those items that were recognized best in the delayed memory task, often required more time to be recognized in the naming task: processing times in the naming task were significantly correlated with recognition scores in the delayed memory task (Pearson $r=.34$, $n=142$, $p<.001$). Regarded per condition, processing times and recognition scores were significantly correlated for typically colored objects ($r=.27$, $n=71$, $p=.025$), and marginally significant for atypically colored ones ($r=.23$, $n=71$, $p=.053$). In both conditions, items that were recognized best in the delayed memory task were associated with longer processing times in the naming task.

Discussion

We report an experiment in which participants first named typically and atypically colored objects, followed by tests of memory for these objects. Atypically colored objects are secondary distinctive: they are different from stored representations of everyday normal objects. We combine an object naming task with an old/new recognition memory task, in order to investigate the processing time hypothesis of the secondary distinctiveness effect. In the naming task, we found that when the color of an object is atypical (e.g., red banana), the object is recognized less quickly than when its color is typical (e.g., red strawberry), replicating results found in object recognition studies (e.g., Therriault et al., 2009). Atypically colored objects were remembered better than typically colored ones as shown in a recognition task that was administered two weeks after the naming task.

We thus found that items that received longer processing in encoding lead to better recognition during the delayed memory test. These results are taken to support a processing time explanation for the secondary distinctiveness effect.

The underlying mechanisms facilitating the secondary distinctiveness effect are subject to debate. The processing time hypothesis explains the effect in terms of mechanisms that occur during encoding of items: distinctive items are processed longer than common ones, and therefore are more memorable (e.g., Kline & Groninger, 1991; Gounden & Nicolas, 2012). Alternative accounts focus on different mechanisms for common and distinctive items at retrieval (e.g., Wadill & McDaniel, 1998). Our experiment contributes to this debate by showing that secondary distinctive items for which a memory effect is obtained (i.e., better recognition in a delayed memory test) indeed receive more processing time during encoding.

Although we have focused on an encoding-based account of the secondary distinctiveness effect, and our results lend support to this account, we do not rule out the importance of retrieval processes. We take the present results to indicate that differential processing at encoding may account for at least a portion of the secondary distinctiveness effect, but this does not preclude effects of differences in retrieval. In fact, the correlation we find between processing time in naming and recognition score in memory is significant, but not very strong, leaving variation to be explained by retrieval-based interpretations of the superior memory for secondary distinctive items over common items. This can be researched for example by measuring retrieval times. Our research design however did not allow us to do that, as response times in the old/new recognition task not only reflect retrieval, but also the perceptual process of recognizing the objects on the screen. And, as we have seen, typically and atypically colored objects significantly differ on that measure.

Our findings give rise to further questions. One question concerns the nature of the distinctiveness effect that can be obtained with atypically colored stimuli. Changing the color of stimuli is arguably a very subtle manipulation of secondary distinctiveness. More extreme manipulations may however boost retrieval based effects. This is suggested by a cue-based explanation of the effect, which states that distinctive items provide more cues that can be used during retrieval, and that therefore the secondary distinctiveness effect occurs (e.g., Wadill & McDaniel, 1998). When, for example, stimuli are distinctive because they consist of two objects 'fused' into one (e.g., Michelon et al., 2003), or because they possess multiplied protruding attributes (e.g., Gounden & Nicolas, 2012; Nicolas & Marchal, 1998), such items also have more cues to be used during retrieval. Our stimuli however were minimally different: the only difference between common and distinctive items was their color. Accordingly, secondary distinctive items did not contain a higher number of cues or attributes that distinguished them from common items, but only attributes with a different 'value'. This makes it less likely that these cues may lead to differential effects *during retrieval*. Further research may therefore address the hypothesis that different *encoding* of distinctive and normal stimuli only accounts for secondary distinctiveness effects when stimuli that are minimally different from common stimuli are used. Only in such a case, during retrieval no higher number of cues is available for distinctive stimuli.

Other directions for future research concern the experimental design of our study. The recognition memory task was administered twice for each participant: directly after

[1] Initial analyses concerning whether the number of days between the initial and delayed memory test affected recognition scores showed a weak correlation between the number of days and the size of the color typicality effect (r=0.28, p=.08), indicating that the effect was slightly stronger for participants who were at the longer end of the delay spectrum than participants who were at the shorter end. This means that a part of the variation in recognition scores could be attributed to the length of the delay, even though delay did not exert a significant main effect on recognition scores. We did not add this delay as a covariate in analyses of effects of color typicality, because color typicality was manipulated within participants, and was therefore impossibly confounded by delay.

the naming task and two weeks later. We opted for this design so that we could determine from the immediate memory test whether using a naming task as an incidental learning paradigm was successful. However, it is yet unclear what the role of the immediate memory task is in the results we found in the delayed task. Educational psychologists point out that initial testing significantly improves outcomes in a successive test (i.e., test-enhanced learning; Roediger & Karpicke, 2006). Although we have no reasons to assume that such a testing effects may interact with a secondary distinctiveness effect, in future studies we will not administer an immediate test.

Additionally, in future work the naming task may be replaced by other tasks which do not involve retrieving the verbal label for the objects, but measure how quickly visually presented objects are recognized in another way. For example, a verification task can be used (e.g., Therriault et al., 2009, experiment 1b). By doing so, processing time of visually presented objects is measured more directly than with a naming task, as potential effects caused by retrieving the verbal label from memory or producing a response can be avoided. For example, naming latencies for atypically colored objects may be longer because participants suppress mentioning the object's color. This is however unlikely, as our instructions stressed responding as quickly as possible (encouraging brief responses), and as participants had no trouble suppressing mentioning color (and hardly ever did so).

Acknowledgements

We thank Karin van Nispen, Eva van den Bemd, and four anonymous reviewers for commenting on an earlier version of this paper, and Ruud Mattheij for his assistance in using MATLAB.

References

Boersma, P. & Weenink, D. (2012). Praat: Doing phonetics by computer, version 5.3.06.

Gounden, Y. & Nicolas, S. (2012). The impact of processing time on the bizarreness and orthographic distinctiveness effects. *Scandinavian Journal of Psychology, 53*, 287–294.

Graesser, A. C., Woll, S. B., Kowalski, D. J., & Smith, D. A. (1980). Memory for typical and atypical actions in scripted activities. *Journal of Experimental Psychology: Human Learning and Memory, 6*(5), 503–515.

Hunt, R. R. & Worthen, J. B. (2006). *Distinctiveness and Memory.* Oxford University Press, Oxford.

Keuleers, E., Brysbaert, M., & New, B. (2010). SUBTLEX-NL: A new measure for Dutch word frequency based on film subtitles. *Behavior Research Methods, 42*, 643–650.

Kline, S. & Groninger, L. D. (1991). The imagery bizarreness effect as a function of sentence complexity and presentation time. *Bulletin of the Psychonomic Society, 29*(1), 25–27.

McDaniel, M. & Bugg, J. (2008). Instability in memory phenomena: A common puzzle and a unifying explanation. *Psychonomic Bulletin and Review, 15*, 237–255.

McDaniel, M. A. & Einstein, G. O. (1986). Bizarre imagery as an effective memory aid: The importance of distinctiveness. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*(1), 54–65.

Michelon, P., Snyder, A. Z., Buckner, R. L., McAvoy, M., & Zacks, J. M. (2003). Neural correlates of incongruous visual information: An event-related fMRI study. *NeuroImage, 19*(4), 1612–1626.

Naor-Raz, G., Tarr, M. J., & Kersten, D. (2003). Is color an intrinsic property of object representation? *Perception, 32*(6), 667–680.

Nicolas, S. & Marchal, A. (1998). Implicit memory, explicit memory and the picture bizarreness effect. *Acta Psychologica, 99*(1), 43–58.

O'Brien, E. J. & Wolford, C. R. (1982). Effect of delay in testing on retention of plausible versus bizarre mental images. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 8*(2), 148–152.

Roediger, H. L. & Karpicke, J. D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science, 17*(3), 249–255.

Schmidt, S. R. (1985). Encoding and retrieval processes in memory for conceptually distinctive events. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11*(3), 565–578.

Schmidt, S. R. (1991). Can we have a distinctive theory of memory? *Memory and Cognition, 19*(6), 523–542.

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). *E-prime 2.0 user's guide.* Psychology Software Tools, Inc., Pittsburg.

Tanaka, J., Weiskopf, D., & Williams, P. (2001). The role of color in high-level vision. *Trends in Cognitive Sciences, 5*(5), 211–215.

Therriault, D., Yaxley, R., & Zwaan, R. (2009). The role of color diagnosticity in object recognition and representation. *Cognitive Processing, 10*(4), 335–342.

Waddill, P. J. & McDaniel, M. A. (1998). Distinctiveness effects in recall: Differential processing or privileged retrieval? *Memory and Cognition, 26*, 108–120.