CATEGORY-SPECIFIC EFFECTS IN OBJECT IDENTIFICATION: WHAT IS "NORMAL"?

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Abstract

Previous research on category-specific effects in subjects with intact brains, have found a disadvantage for the identification of natural objects compared to artefacts. This has been taken to support the explanation that natural object deficits in brain-damaged subjects are nothing more than an exaggeration of a "normal" tendency. More recent investigations have, however, uncovered the opposite normal tendency, an advantage for natural objects (Gerlach, 2001; Laws and Neve, 1999). The present study investigated the possible causes of this discrepancy. Three experiments revealed category-specific disadvantages for natural objects in normal subjects despite using stimulus materials rigorously balanced for a) concept familiarity, b) visual complexity, c) name frequency and d) name length. Furthermore, it was found that the very same set of stimulus materials could lead to natural object advantages as well as natural object disadvantages, depending on whether trials in a matching paradigm were positive or negative. In a naming paradigm, there was no natural object disadvantage when stimulus presentation durations were short. The discrepancy present in the literature can be solved by an account emphasising perceptual strategies instead of invoking a lack of adequate experimental control in the previous studies.

Key words: category specificity, object identification, task demands, natural objects, artefacts

Introduction

Over the last two decades it has become increasingly clear that neurological patients may show recognition or identification problems for a specific category of objects (Caramazza and Shelton, 1998; Forde and Humphreys, 1999). Most of these cases display a disadvantage for the identification of natural objects. That is, such patients typically make more errors when naming animals, fruits and vegetables than when naming man made objects. Why should natural objects be more prone to cognitive impairment after neurological damage than artefacts? Several researchers have suggested that this imbalance reflects a normal tendency (Capitani et al., 1994; Gaffan and Heywood, 1993; Humphreys et al., 1995; Lloyd-Jones and Humphreys, 1997). Somehow, natural objects are different from artefacts in such a way that they are generally more difficult to identify. This difficulty is just more evident in the performance of brain-damaged subjects.

One such explanation is the "visual crowdedness" hypothesis (Gaffan and Heywood, 1993). Proponents of this explanation (e.g., Gale et al., 2001; Humphreys et al., 1988, 1995) suggest that natural objects, as compared to artefacts, generally belong to categories in which members are more structurally similar to each other. Consider for instance the number of animals that have a shape similar to a horse: a donkey, a zebra, an elk, a deer and so on. Even most carnivores, such as wolves and lions, have basic shapes that share many of the features of the horse, e.g. head, trunk, 4 legs, tail. This structural similarity, or visual crowdedness, may be the reason some visual agnosic patients are more prone to have problems identifying natural objects. Forde and Humphreys (1999) suggest that objects from the visually crowded categories require a more detailed visual processing than objects from less visually crowded categories (i.e. most artefacts).

There are several studies indicating the existence of a "normal" tendency (i.e., in the performance of subjects without brain injury) compatible with this type of explanation. Humphreys and his colleagues (Humphreys et al., 1988) have shown that normal subjects are less accurate at identifying objects from structurally similar categories (natural categories) compared to structurally dissimilar categories (artefacts) in a naming task. These results have been replicated, and the disadvantage for natural objects is seen in both object-decision tasks and in picture naming (Lloyd-Jones and Humphreys, 1997). A disadvantage for the naming of natural objects has also been demonstrated independently (Capitani et al., 1994; Laws and Gale, 2002; Moore and Price, 1999), further strengthening the credibility of these findings. In addition, Gaffan and Heywood (1993) found that normal human subjects and non-human primates performed worse with natural objects in a visual discrimination task. All these studies seem to support the visual crowdedness hypothesis. At the very least, they reveal what seems to be a normal tendency toward less efficient processing of visual stimuli belonging to natural object categories.

Recently, however, these findings have been challenged by evidence from a brief-presentation naming paradigm showing a category specific *advantage* for natural objects. In Laws and Neve's (1999) experiments, subjects saw line drawings flashed on the screen for 20 msec, and were required to name them. They made significantly *fewer* errors to stimuli depicting objects from natural categories compared to artefacts. A natural object advantage has later been demonstrated in a number of experiments using object decision and naming (Gerlach, 2001; Laws, 1999, 2000).

Interestingly, Laws and Neve (1999) also rely on structural similarity to explain their findings. However, instead of emphasising the visual crowdedness of natural objects (i.e., similarity between objects from different object classes, e.g., a horse is like a donkey is like a zebra etc.), they direct attention to the presumed fact that within a natural object class (e.g., horses), exemplars are very similar to each other. Within artefact object classes, however, this is typically not the case (e.g., think of the many different shapes a chair comes in). This latter type of similarity, the within object class similarity, being higher for natural objects, may cause an advantage for this domain in identification.

Such diverging results create problems for any account that attributes the asymmetric prevalence of certain types of category specific deficits in brain-injured patients to exaggerations of normal tendencies. The obviously necessary empirical foundation for such an account is a stable normal tendency. Moreover, unexplained divergences in any set of empirical findings raise concerns about the validity of some or all of those findings. If such a discrepancy is caused by uncontrolled and unsystematic variations in unknown variables, then the findings will have no theoretical significance. In any case, if category specific effects in neurologically healthy individuals are to be considered relevant to the understanding of category-specific agnosias, the contradictory findings must somehow be reconciled.

Two different accounts have been given to explain the contradictory findings. Laws and Neve (1999) attributed the natural object disadvantage of early studies to a lack of experimental control. Thus, according to these researchers, it is the natural object advantage, not disadvantage, that reflects the real normal tendency. The suggestion that the control of nuisance variables such as familiarity and visual complexity (c.f., Funnel and Sheridan, 1992; Stewart et al., 1992) has been less than adequate in the experiments demonstrating a natural object disadvantage is certainly accurate. None of these studies controlled for visual complexity (e.g. the amount of detail or intricacy of line in a picture as rated by subjects), and some of them also lacked control of concept familiarity (e.g., Gaffan and Heywood, 1993; Humphreys et al., 1988; Laws and Gale, 2002). In contrast, all of the experiments demonstrating a natural object advantage used stimulus materials balanced for both visual complexity and concept familiarity, as well as for name frequency.

An alternative account, proposed by Gerlach (2001), emphasises two characteristics of the situation in which the identification takes place: First, the importance of perceptual differentiation for solving the task: The higher the task demands on perceptual differentiation, the more disadvantaged will be the natural objects because of their higher structural similarity. For instance, an object decision task (i.e., deciding whether an object is real or not) where non-objects are composed of parts of real objects is likely to elicit competition between representations of objects belonging to different object classes. This creates high demands on perceptual differentiation, and thus any similarity between the objects involved will tend to make the task harder. In an object decision task in which non-objects are simply closed nonsense figures, there will likely not be elicited competition between representations of objects belonging to different object classes. Thus, demands on perceptual differentiation are lower, and visual crowding is less likely to affect the process. Note that whenever the term task demands is used in this text henceforth, it is with the preceding definition in mind.

Second, the conditions under which the stimuli are viewed: If stimuli are presented in such a way that visual detail is obscured (e.g., in peripheral vision, very briefly, or as silhouettes or low-pass filtered images), this will tend to work in favour of the natural objects, such that these will be relatively advantaged. The second point is based on the assumption that natural objects compared to artefacts reveal more of their identity through their global shape because of their higher within object class similarity. Thus, when detail is omitted from the input and identification must rely on global shape, natural objects will be relatively easier to identify than artefacts. This assumption is supported by findings that demonstrate the role of outline information in object recognition (Hayward, 1998). In particular, recent findings by Lloyd-Jones and Luckhurst (2002) lead them to argue that outline shape is a particularly important mediator of recognition for living things, although as their findings and other's (Laws, 2002) indicate, natural objects may be more easily identified even when identification can rely on more than global shape or object outline.

In two experiments using object-decision tasks, Gerlach's subjects showed a disadvantage for natural objects when the object decision task was difficult (high demands on perceptual differentiation) and the viewing conditions were optimal (providing detail), no difference between categories when the object decision was easy (low demands on perceptual differentiation) and viewing conditions optimal (providing detail), and an advantage for natural objects when the object decision was easy (low demands on perceptual differentiation) and viewing conditions sub-optimal (i.e. stimuli presented in peripheral vision, thus defocusing detail). This evidence appears to be compatible with an account based on task demands and viewing conditions. However, the effect of viewing conditions was investigated only with the easy object decision task, and so, viewing conditions and demands on perceptual differentiation could have been at least partly confounded in these experiments.

The present experiments were aimed at providing evidence that could help us to evaluate the two accounts described above by (i) employing the same set of rigorously balanced stimulus materials in all experiments and conditions, thus ruling out an explanation that attributes category effects to a lack of experimental control, and (ii) disentangling the effects of task demands and viewing conditions (i.e., speed of presentation of the stimuli). Experiment 1 examined specific effects of task demands in a name verification task with stimuli very briefly (20 msec) presented. Experiment 2 was identical to Experiment 1, only this time the viewing conditions were optimal (i.e. presentation time was 1000 msec). Experiment 3 examined the category specific effects of presentation time in a naming task.

Experiment 1

In order to manipulate the task demands on perceptual differentiation, while at the same time holding as many other factors as possible constant and also manipulating the category of the objects, a name verification task was chosen. In this task, subjects briefly saw a line drawing of an object before an object name appeared. Their task was to confirm or disconfirm (by pressing keys labelled accordingly) whether the pairing of drawing and object name was correct. It was assumed that in the positive trials, where picture and name matched, the converging activation of an object's representation from both text and picture stimuli would place low demands on visual differentiation. In the negative trials, where picture and object name mismatched, and so activate representations of objects from different classes, demands on differentiation were higher. The demand on perceptual differentiation was optimised in the negative trials by choosing the mismatched picture and word from the same domain of objects. Thus, in the present experiment, positive trials were treated as a low demand condition, whereas negative trials were treated as a high demand condition. Following Gerlach's (2001) explanation, it would be expected that the high demand condition would lead to a disadvantage for natural objects and that the low demand condition would lead to an advantage for natural objects. However, since Gerlach additionally emphasise the importance of stimulus presentation conditions, (i.e., sub-optimal presentations, such as the brief (20 msec) presentation used here, tends to favour natural objects), any natural object disadvantage in the high demand condition might be attenuated or even eliminated.

Also, since the stimuli in the present experiment were balanced on the important nuisance variables neglected in some early studies (i.e. visual complexity and concept familiarity, as well as word frequency and word length), a natural object disadvantage would not be expected in any condition if such was caused by lack of experimental control as suggested by Laws and Neve (1999).

Method

Participants. Thirty normal participants, 17 women and 13 men, aged between 19 and 39, all volunteers and students at the University of Tromsø participated. All had normal or corrected to normal vision.

Materials. Forty line drawings, 20 natural objects and 20 artefacts, taken from the Snodgrass and Vanderwart (1980) stimulus set, were used. The line drawings were fitted within a 4.5 by 4.5 cm square and on screen they subtended approximately 3.5 degrees of visual angle. Each line drawing was paired twice with an object name. Once with the name corresponding to the object depicted, and once with the randomly chosen name corresponding to one of the 19 other objects in the same category (natural or artefact). The name was printed in Arial font (40 pt size) capital letters and centered at the point of fixation. Four groups of stimuli were created, corresponding to the four within-subject conditions of the experiment: 1) low demand, natural objects; 2) low demand, artefacts; 3) high demand, natural objects; 4) high demand, artefacts. Examples are given in Figure 1. Also, 12 practice trials were made from stimuli not used in the experimental trials.

A number of stimuli aspects deemed likely to influence the results were equated across category. First, three well established influences on object processing were balanced, thus, name frequency, estimated on the basis of searches made in "The Oslo Corpus of Tagged Norwegian Texts" (Tekstlaboratoriet, 2001), was equated for natural objects ($M = 49.8$, $SD = 66.99$) and artefacts ($M = 50.1$, $SD = 57.8$), $t(38) = .02$, $p > .9$, concept familiarity as given in Snodgrass and Vanderwart (1980) was equated for natural objects ($M = 2.9$, $SD = .9$) and artefacts ($M = 3.0$, $SD = .7$), $t(38) = .1$, $p > .8$, and visual complexity as given in Snodgrass and Vanderwart (1980) was equated for natural objects ($M = 3.3$, $SD = .7$) and artefacts ($M = 3.4$, $SD = .9$), $t(38) = .5$, $p > .6$. Since the stimuli were partly constituted by the written names of the objects, they were chosen so that the average length of the objects' names in character

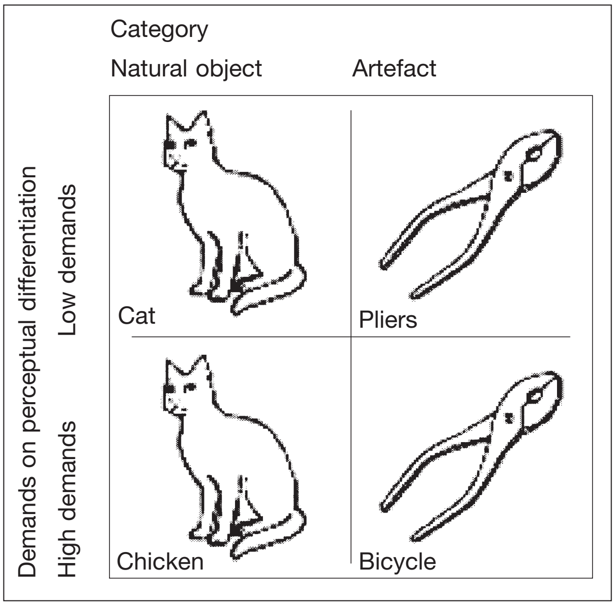

Fig 1 – *Example stimuli used in Experiment 1 and 2.*

spaces was equated between the groups. This was done to control for word-length reading-time effects. Thus, the word length of natural objects (M = 5.9, SD = 1.9) was balanced with that of artefacts (M = 6.1, SD = 2.3), t (38) = .3, p > .7.

Procedure. Stimuli were presented, and responses recorded, using SuperLab™ software running on a portable computer. All stimuli, except practice trials, which were presented first, were presented in a different random order for each participant. Participants first read instructions on the computer screen. The experimenter then repeated the instructions orally. Each trial proceeded as follows: (i) A fixation point in the form of a black cross displayed in the middle of the white screen for 200 msec; (ii) a brief presentation of a line drawing for 20 msec in the middle of the screen; (iii) a name was then presented in place of the drawing for 5000 msec, during which time the participant had to respond. Participants were asked to press a button labelled "YES" (in Norwegian) if they thought the name matched the drawing, and to press "NO" if they thought the name and drawing were a mismatch. Participants were told to be as fast and as accurate as possible. One experimental session took approximately 15 minutes to complete. Both accuracy (error rates) and latency (response times – RTs) served as dependent measures.

Results

Separate repeated measures ANOVAs were conducted on error rates and RTs to correct responses. There were two within-subject factors: demands on visual differentiation (low vs. high); and category (artefacts vs. natural objects). Mean error rates and RTs with standard deviations, averaged over subjects, for the four experimental conditions, are given in Table I.

The ANOVA by subject on error rates revealed no significant main effects. There was, however, a significant interaction between category and differentiation demands, F_1 (1, 29) = 37.7, p < .001. The ANOVA by item also revealed a significant interaction, F_2 (1, 19) = 16.3, p < .001. As predicted by considerations concerning demands on perceptual differentiation, t-tests (t-tests, here and elsewhere, were done on participants) revealed a significant difference, t (29) = 3.13, p < .01, between natural objects and artefacts with fewer errors for natural object items in the low demand condition. There was also a significant difference between the two categories in the high demand condition, t (29) = 5.59, p < .001, with more errors to natural object items, despite the sub optimal presentations and well balanced stimulus materials.

Latency data displayed the same general pattern as the error rates data. All RTs greater than three standard deviations from each individual's mean of correct trials in each condition were removed. The percentage of response latencies discarded was 1.5% for the artefacts low demand condition, 1.5% for the natural objects low demand condition, 1% for the artefacts high demand condition, and 0.67% for the natural objects high demand condition. The ANOVA by subject on RTs revealed a main effect of demands on perceptual differentiation, F_1 (1, 29) = 7.1, p < .05, with shorter latencies in the low demand condition. There was also an interaction between category and differentiation demands, F_1 (1, 29) = 8.1, p < .01. In the ANOVA by items, there was also a significant main effect of differentiation demands, F_2 (1, 19) = 13.5, p < .01. The interaction between category and differentiation demands was only marginally significant in the by item analysis, F_2 (1, 19) = 3.2, p = .09. T-tests revealed no difference, t (29) = 1.45, p = .15 between natural objects and artefacts in the low demand condition. In the high demand condition there was a significant difference

TABLE I

Mean error rates and RTs for Experiment 1

	% Errors		Response times	
	M	SD	M	SD
Natural objects, low demands	13.8	11.9	945	212
Artefacts, low demands	18.7	10.6	978	229
Natural objects, high demands	15.7	14.1	1069	322
Artefacts, high demands	7.0	7.3	1012	281

TABLE II
Mean error rates and RTs for Experiment 2

	% Errors		Response times	
	M	SD	M	SD
Natural objects, low demands	4.2	4.55	640	170
Artefacts, low demands	7.9	8.0	694	191
Natural objects, high demands	2.9	6.0	702	242
Artefacts, high demands	1.2	2.2	669	194

between the two categories, t (29) = 2.59, $p < .05$, with longer RTs for natural object items.

Discussion

The category specific disadvantage obtained in the high demand condition of this experiment disappeared, and was even reversed (in the error rates data) in the low demand condition. These findings replicated Gerlach's (2001) results that demands on perceptual differentiation will have opposite effects on the identification of natural objects and artefacts. It also suggested, pace Laws and Neve (1999), that lack of experimental control in early experiments (e.g. in Gaffan and Heywood, 1993; Humphreys et al., 1988) may not be the only cause of a natural object disadvantage. However, such a conclusion may be premature, as the task used in this experiment is not the same as those used in the early studies. It also worth noting that despite the short stimulus presentation time (20 msec), the natural object disadvantage was clearly evident in the high demand condition, suggesting that some task parameters take precedence over others, such as speed of stimulus presentation. The influence of viewing conditions cannot be adequately evaluated on the basis of this experiment, though, since only brief presentations were used.

Experiment 2

Thus, Experiment 2 was designed to serve as a basis, together with Experiment 1, for evaluating the influence of viewing conditions. Experiment 2 is identical to Experiment 1 in all respects, except for the stimulus presentation time, which was lengthened to 1000 msec.

Method

Participants. Thirty normal participants, 19 women and 11 men, aged between 20 and 45, all volunteers and students at the University of Tromsø participated. All had normal or corrected to normal vision. None had participated in Experiment 1.

Materials and Procedure. See Experiment 1. Experiment 2 is identical to Experiment 1, except that picture stimuli were presented for 1000 msec, instead of 20 msec.

Results

Separate repeated measures ANOVAs were conducted on error rates and RTs to correct responses. There were two within-subject factors: demands on visual differentiation (low vs. high); and category (artefacts vs. natural objects). Mean error rates and RTs with standard deviations, averaged over subjects, for the four experimental conditions, are given in Table II.

The ANOVA by subject on error rates revealed a main effect of demands on perceptual differentiation, F_1 (1, 29) = 13.6, $p < .001$, with more errors in the low demand condition than in the high demand condition. There was no main effect of category. There was, however, a significant interaction between category and differentiation demands, F_1 (1, 29) = 9.0, $p < .01$. The ANOVA by item also revealed a main effect of differentiation demands, F_2 (1, 19) = 11.0, $p < .01$, and a significant interaction, F_2 (1, 19) = 8.8, $p < .01$. As predicted by considerations concerning demands on perceptual differentiation, t-tests revealed a significant difference, t (29) = 2.92, $p < .01$, between natural objects and artefacts with fewer errors for natural object items in the low demand condition, despite the optimal viewing conditions. The difference between the two categories, with more errors to natural object items in the high demand condition, was not significant.

The latency data were processed in the following way. All RTs greater than three standard deviations from the mean of the correct trials in each condition were removed. The percentage of response latencies discarded was 1.0% for the artefacts low demand condition, 1.17% for the natural objects low demand condition, 1.33% for the artefacts high demand condition, and 1.0% for the natural objects high demand condition. The ANOVA by subject on RTs revealed an interaction between differentiation demands and category, F_1 (1, 29) = 12.9, $p < .001$. No other effects reached significance. In the ANOVA by item, this interaction remains, F_2 (1, 19) = 9.6, $p < .01$. T-tests revealed a significant difference, t (29) = 3.16, $p < .01$, between natural objects and artefacts with shorter RTs to natural object items in the low demand condition, despite the long stimulus presentation times. There was also a marginally significant difference between the two categories, t (29) = 1.92, $p = .06$, with longer RTs to natural object items in the high demand condition.

Discussion

The main finding of Experiment 1, namely the interaction between demands on perceptual differentiation and category, was replicated in Experiment 2. It might seem reasonable therefore, to tentatively conclude that low demands on visual differentiation tend to favour natural objects whereas high demands tend to favour artefacts, although the latter effect was not significant for response times in Experiment 2.

As described earlier, one possible account of these findings, which draws on suggestions by both Laws and Neve (1999) and by Gerlach (2001), emphasises the higher structural similarity of natural objects. Note that what is relevant from this perspective is the similarity within each object class, and not so much the similarity between different members of higher order categories (horse looks like donkey and so on, cf. Humphreys et al., 1988). That is, the similarity that typically exists between all horses, whether it is a shire horse, a pony or a quarter horse. This "within object class similarity" could make the global shape of a natural object more efficient in accessing its stored representations than the global shape of artefacts. Thus, if certain conditions prevail, such as a task's lack of a tendency to elicit competition between representations of different objects, this may cause natural objects to be advantaged compared to artefacts.

However, the long stimulus presentation time used in this experiment did not cause the natural object advantage in the low demand condition to disappear. Moreover, in Experiment 1, there was a natural object disadvantage, despite very brief stimulus presentation. Thus, results so far seem to indicate that the effects of viewing conditions are negligible.

Experiment 3

Experiment 3 was designed to examine the influence of viewing conditions on the *naming* of natural objects and artefacts. In this experiment participants saw the same well-balanced picture stimuli used in Experiments 1 and 2. In Experiment 3, however, participants were simply told to name the objects. Each picture was shown twice; once with very short (20 msec) presentation time, and once with long (1000 msec) presentation time. The constraints set by the task were thus identical in the two presentation conditions, the only difference being the time participants were allowed to view the stimuli.

Experiment 3 was motivated by three considerations. First, it was suspected that the constraints imposed on the identification process by the positive and negative trials in Experiment 1 and 2 were so strong as to override effects of viewing conditions. By employing a naming task, it was assumed that any such constraints would be eliminated, since in a naming task there are no matching versus mismatching trials. Second, assessing the influence of viewing conditions in a within-subject design, instead of a between-subjects experiment, can give a more direct and stringent test of any potential effects. Third, the relevance of any findings in the present experiments to the discrepancy between the findings of Laws and Neve (1999) and Humphreys et al. (1988) will be clearer when using the same task used in their experiments.

Method

Participants. Forty normal participants, 22 women and 18 men, aged between 21 and 47, all volunteers and students at the University of Tromsø participated. All had normal or corrected to normal vision.

Materials. The same forty line drawings (20 natural objects and 20 artefacts) used in Experiments 1 and 2 were used. Each line drawing was presented twice, once very briefly (20 msec) and once for a longer period of time (1000 msec). Thus, four conditions were created: 1) brief presentation, natural objects; 2) brief presentation, artefacts; 3) long presentation, natural objects; 4) long presentation, artefacts. Also, practice trials were made from stimuli not used in the experimental trials. The stimuli were balanced on a number of different nuisance variables, as described in the methods section of Experiment 1.

Procedure. Stimuli were presented, and response latencies recorded, using SuperLab^{TM} software running on a portable computer, hooked up to a microphone. The experimenter recorded the accuracy of the responses, whereas the response times were recorded by means of the computer's voice key. All stimuli were presented in random order. Participants first read instructions on the computer screen. The experimenter then repeated the instructions orally. Each trial proceeded as follows: (i) A fixation point in the form of a black cross displayed in the middle of the white screen for 200 msec. (ii) A presentation of the object line drawing for 20 or 1000 msec in the middle of the screen. (iii) A blank white screen for 1500 msec, or until the participant responded. Participants were asked to simply name the objects they saw, with no instructions as to how specific or general the names should be. Participants were told to be as fast and as accurate as possible. One experimental session took approximately 15 minutes to complete. Both accuracy (error rates) and latency (reaction times – RTs) served as dependent measures.

Results

Separate repeated measures ANOVAs were conducted on error rates and RTs to correct

TABLE III
Mean error rates and RTs for Experiment 3

	% Errors		Response times	
	M	SD	M	SD
Natural objects, brief presentation	7.25	0.85	648	25
Artefacts, brief presentation	7.55	0.85	667	26
Natural objects, long presentation	4.88	0.80	948	31
Artefacts, long presentation	5.25	0.55	910	25

responses. There were two within-subject factors: presentation time (brief vs. long); and category (artefacts vs. natural objects). Mean percentage of errors and RTs with standard deviations, averaged over subjects, for the four experimental conditions, are given in Table III.

The ANOVA by subject on error rates revealed a main effect of presentation time, F_1 (1, 39) = 13.6, p < .001, with more errors in the brief presentation condition than in the long presentation condition. The analysis by item confirmed this effect, F_2 (1, 19) = 21.0, p < .001. There were no other effects on error rates.

The latency data were processed in the following way. All RTs greater than three standard deviations from the mean of the correct trials in each condition were removed. The percentage of response latencies discarded was 1.63% for the artefacts brief presentation, 1.13% for the natural objects brief presentation, 2.88% for the artefacts long presentation condition, and 2.13% for the natural objects long presentation condition. The ANOVA by subject on RTs revealed a main effect of presentation time, F_1 (1, 39) = 224.9, p < .001, with faster responses in the brief presentation condition. There was also an interaction between presentation time and category, F_1 (1, 39) = 5.1, p < .05. In the ANOVA by item, both the main effects of presentation time, F_2 (1, 19) = 521.6, p < .001, and the interaction, F_2 (1, 19) = 5.7, p < .05, remains. T-tests revealed a significant difference, t (39) = 2.14, p < .05, between natural objects and artefacts with longer RTs to natural object items in the long presentation condition. There was no difference between the two categories, t (39) = 1.06, p > .25, in the brief presentation condition.

A look at Table III reveals that in the long presentation condition, the error means, although not significant, runs in the opposite direction from the latency means. This might indicate a speed accuracy trade off. Therefore, Pearson correlations between errors and response latencies were run for this condition. The relationship was positive for both artefacts (r = .15, p = 35) and natural objects (r = .80, p < .001). Thus, there is no speed accuracy trade off.

Discussion

The results of this naming experiment confirmed the category specific influence of viewing conditions on object identification hypothesised by Gerlach (2001). The natural object disadvantage observed in the optimal (long presentation) condition disappears in the sub-optimal (brief presentation) condition. Although there was no clear natural object advantage in the sub-optimal viewing condition, the observed interaction between category and presentation time indicates that inconsistencies in findings of natural object advantages and disadvantages may be explained by appeal to viewing conditions. Certainly, the interaction cannot have been caused by differences in the experimental control of nuisance variables, as the very same stimulus materials were used in both the optimal and the sub-optimal condition.

The lack of a clear advantage in the fast presentation condition is at odds with the findings of Laws and Neve (1999), who did find an advantage in their subjects' error rates. Still, the trend observed in the latency data of the present experiment does go in the same direction. The slightly smaller stimulus set used in the present experiment may account for the difference.

It is interesting that presentation time interacts with category in this experiment, despite the lack of any difference between Experiment 1 and 2. One possible explanation emerges when one considers how the concept of task demands, as previously defined, applies to the naming task. In the name verification paradigm, positive trials are not likely to induce competition between representations of different object classes, since both picture and name will converge to activate the same object representation. For the negative trials, picture and name will diverge to activate different representations, and they are thus more likely to induce competition. In a simple naming paradigm, however, the constraints provided by the object names in the verification paradigm are lacking. A naming task may thus be considered intermediate in task demands. This may give some leeway into which viewing conditions can affect the processing.

General Discussion

The results of the present experiments seem to show, contrary to the assumptions of Laws and Neve (1999), that the discrepancy between findings of a natural object disadvantage in early experiments (e.g. Humphreys et al., 1988; Lloyd-Jones and Humphreys, 1997) and a natural object advantage in later experiments (Laws and Neve, 1999) may not be due to differences in the experimental control of nuisance variables. The present experiments use carefully balanced stimulus materials, and the same set of stimuli under different task demands, and still produces both natural object disadvantages (Experiments 1, 2 and 3) and natural object advantages (Experiments 1 and 2). Thus, although a number of experiments showing a natural object disadvantage undoubtedly lack control of some important nuisance variables (e.g., Gaffan and Heywood, 1993; Humphreys et al., 1988; Laws, 2000; Lloyd-Jones and Humphreys, 1997), the category effects they produce cannot necessarily be attributed to this lack of control. Normal category specific asymmetries in object identification is not a question of whether there is an advantage or a disadvantage for natural objects, but rather, a question of what conditions precipitates the one or the other.

Knowledge of these conditions, in particular the task used and the viewing conditions of the stimuli, should inform our evaluations of category-specific deficits whenever they occur in brain-damaged patients. Since these conditions evidently differentially affect processing of natural objects and artefacts, they should be taken into consideration. A natural object deficit in a brain-damaged patient may indeed reflect a 'normal' asymmetry, particularly if displayed under optimal viewing conditions or with a task that favours artefacts. On the other hand, a natural object deficit displayed under conditions that would normally favour natural objects should have us looking for other underlying causes.

The conditions and tasks under which the normal category specific advantages for either artefacts or natural objects occur should also lead us to speculate on the possible mediators between task demands and conditions and the category specific behavioural outcome. The visual crowdedness hypothesis (Gaffan and Heywood, 1993; Humphreys et al., 1988) provides one possible explanation for the natural object disadvantages, based on the assumption that the supposedly higher structural similarity between classes of natural objects (a horse looks like a zebra etc.) causes a need for a more detailed visual analysis (Forde and Humphreys, 1999). In contrast, in the account sketched by Laws and Neve (1999) and by Gerlach (2001) it is the higher similarity *within* basic level object classes (one horse looks very much like any other horse) that actually benefits the natural objects in some circumstances and causes the natural object advantage. On the basis of the present results, one might speculate that task demands and conditions inducing different perceptual strategies might thereby cause reliance on one or the other type of structural similarity.

However, the precise roles of structural similarity in category-specific effects and deficits remain uncertain, as there is no direct evidence for these speculations. There is even controversy over the assumption of visual crowdedness for natural objects (see debate: Humphreys and Riddoch, 2002; Laws and Gale, 2002). Still, whatever the role of structural similarity ultimately turns out to be, the present experiments leave little doubt that differences in task characteristics can induce differences in relative object identification performance for natural objects and artefacts.

Acknowledgements. This research was supported by a grant from The Research Council of Norway (grant nr. 148218/330). Thanks to Bruno Laeng and Tim Brennen for useful advice during the writing of this article, and to Christian Gerlach for constructive comments on an earlier version of the manuscript.

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(*Received 23 April 2003; reviewed 30 July 2003; revised 5 September 2003; accepted 8 October 2003; Action Editor John Crawford*)

APPENDIX A

Stimuli Used in the Experiment

Natural objects	Artefacts
Bear	Axe
Chicken	Aeroplane
Banana	Violin
Crocodile	Screw
Cat	Chisel
Kangaroo	Pliers
Squirrel	Helicopter
Strawberry	Saw
Pepper	Accordion
Leopard	Motorcycle
Fox	Bicycle
Monkey	Wagon
Penguin	Harp
Orange	Hammer
Artichoke	Bus
Sparrow	French horn
Onion	Nail
Dog	Trumpet
Carrot	Paintbrush
Grapes	Guitar