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Similarity and Categorisation: Getting Dissociations in Perspective

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Abstract

Dissociations between similarity and categorization have constituted critical counter-evidence to the view that categorization is similarity-based. However, there have been difficulties in replicating such dissociations. This paper reports three experiments. The first provides evidence of a double dissociation between similarity and categorization. The second and third show that by asking participants to make their judgments from particular perspectives, this dissociation disappears or is much reduced. It is argued that these data support a perspectival view of concepts, in which categorization is similarity-based, but where the dimensions used to make similarity and categorization judgments are partially fixed by perspective.

Introduction

Explanations of categorisation have undergone a number of theoretical shifts (Medin, 1989), from classical to prototype models, and from prototype to theory-based models (e.g., Murphy & Medin, 1985). One of the key pieces of evidence against similarity-based models has been the finding that similarity and categorisation judgments can dissociate. For example, Rips (1989) found that participants judged an unknown item more similar to a coin yet more likely to be a pizza; and a bird transformed to look like an insect as more similar to an insect, yet more likely to be a bird.

Dissociations between similarity and categorization judgments appear directly to undermine similarity-based models of categorization. Prototype models, for example, assume that categorisation involves a similarity comparison between an object and a prototype in memory (e.g., Hampton, 1995). Exemplar-based models assume that a similarity comparison is made between an object and sets of exemplars in memory (e.g., Kruschke, 1992). In both kinds of model, categorization is taken to be a monotonic increasing function of similarity. That is, according to similarity-based models, it should not be possible for categorization to increase without a corresponding increase in similarity. These models thus deny the possibility of two kinds of phenomena: i) a decrease in categorization accompanied by an increase in similarity; and ii) a decrease in categorization accompanied by no change in similarity.

In spite of the evidence and arguments in support of similarity-categorisation dissociations (henceforth,

SCD), similarity-based models have maintained their appeal. Some of this can be attributed to the apparent success of similarity-based models in explaining much categorization data (cf. Hampton, 1998) even if SCDs remain as recalcitrant cases. But similarity-based models have also retained their appeal because the existence of SCDs has been questioned (despite other apparent demonstrations – e.g., Kroska & Goldstone, 1996; Roberson, Davidoff & Braisby, 1999). Smith & Sloman (1994), in seeking to replicate Rips' results, were able only to produce a SCD when participants were required to operate in a reflective, rule-based mode, by giving a concurrent. Similarly, Estes & Hampton (2002) only obtained a SCD when using a within-participants design; a between-participants design failed to show a dissociation. In contrast, Thibaut, Dupont & Anselme (2002) obtained SCDs in two experiments. Their participants were required to learn two artificial categories, exemplars of which were novel shapes. They found that participants tended to judge category membership according to the presence of a necessary feature, but similarity according to the presence of a salient characteristic feature.

Thibaut et al.'s results show that SCDs can arise without participants entering a reflective mode of categorization. However, it does not demonstrate that natural (as opposed to artificial) categories give rise to SCDs. That is, they have shown that participants can learn and use non-similarity-based categories, but not that natural categories are not similarity-based.

This paper seeks to add to this debate concerning SCDs and, more widely, similarity-based models of concepts by i) attempting to demonstrate a double similarity-categorisation dissociation; and ii) showing that such dissociations can be eliminated or diminished.

Previous work (e.g., Thibaut et al.) has shown that stimuli defined by the presence of both necessary and characteristic features may be categorized according to the necessary feature, and rated for similarity according to the characteristic feature. Of course, such work also implies the existence of two kinds of (potentially) borderline case: (a) an exemplar possessing the necessary but not the characteristic feature (N+C−); and (b) an exemplar possessing the characteristic but not the necessary feature (N−C+). According to the rationale extended by Thibaut et al., exemplar (a) should receive a high categorisation but low similarity rating, and (b)

should receive a low categorization but high similarity rating. Together these borderline cases could provide a double dissociation, and potentially more robust evidence of SCDs.

This paper also seeks to establish whether SCDs are context-sensitive. That is, it is possible that in context, categorization judgments are similarity-based, but that dissociations arise when categorization and similarity judgments are elicited in the absence of any specific context. If so, then the mixed evidence reported in the literature may stem from minor variations in task presentation, and it might be possible to retain a similarity-based model in which the weighting of features varies with context.

Experiment 1

This experiment sought to establish whether similarity and categorization judgments for biological categories dissociate for two kinds of borderline case: Appearance+Genetics− and Appearance−Genetics+.

Design

Task (Typicality, Categorisation), Appearance (A+,A−) and Genetics (G+,G−) were within-participants factors.

Method

Participants 40 undergraduate psychology students attending an Open University residential school volunteered to participate.

Materials Four food categories were chosen based on previous work (Braisby, 2001): salmon, apple, potato and chicken. Sixteen scenarios were constructed, as described below, so that there were four exemplars per category defined by the presence or absence of appearance and genetic properties: A+G+; A+G−; A−G+; and A−G−. The following shows how scenarios were constructed for the category 'apple'; the first set of brackets indicates wordings for G+ and G− conditions, and the second set indicates the A+ and A− wordings.

"You have just bought an apple from a reputable retailer. On examining its packaging closely, you find that it has been genetically modified [but it retains ALL/so that it has NONE] of the genetic properties specific to apples. On closer examination, you find that it [looks, feels, smells and even tastes JUST/does NOT look, feel, smell or even taste] like an apple."

Procedure All scenarios were presented and responses recorded using E-prime (Schneider, Eschman & Zuccolotto, 2002). Participants were given a practice example, and then asked to read the 16 scenarios. After each, participants first judged the category membership of the exemplar given the category label (e.g., apple), choosing either a Yes or No judgment. They then rated
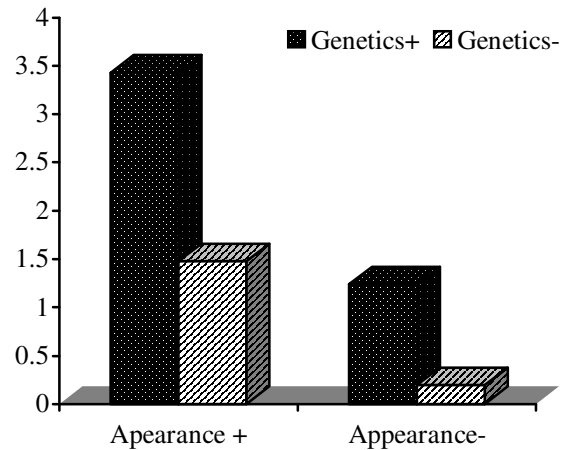

Figure 1. Overall ratings by Appearance and Genetics.

the exemplar for typicality on a 7-point scale relative to the category label. The typicality question is taken to be an index of similarity (cf. Hampton, 1998). Order of presentation of scenarios was random.

Results

Responses to the categorization question were summed over the four categories, yielding a scale of 0 to 4; the typicality question was transformed to the same scale (high scores imply high typicality and high categorization probability). Both typicality and categorization scores were analysed using ANOVA with Task (Typicality, Categorisation), Appearance (+,−) and Genetics (+,−) all within-participant factors.

There was no effect of Task ($p = 0.61$), but main effects of Appearance [$F(1,39) = 149.29$, $p < 0.001$; $\eta^2 = 0.79$] and Genetics [$F(1,39) = 109.59$, $p < 0.001$; $\eta^2 = 0.74$], interactions between Task and Appearance [$F(1,39) = 14.30$, $p < 0.01$; $\eta^2 = 0.27$], Task and Genetics [$F(1,39) = 11.63$, $p < 0.01$; $\eta^2 = 0.23$], Appearance and Genetics [$F(1,39) = 21.17$, $p < 0.001$; $\eta^2 = 0.35$], all subsumed by a marginal three-way interaction between Task, Appearance and Genetics [$F(1,39) = 3.88$, $p = 0.06$; $\eta^2 = 0.09$]. The key interactions between Appearance and Genetics, and between Task, Appearance and Genetics, are shown in Figures 1, and 2 and 3 respectively.

Pair-wise comparisons were conducted to examine the locus of the three-way interaction between Task, Appearance and Genetics. There was no effect of Task for either of the clear cases, i.e., either the A−G− or the A+G+ cases. However, there was an effect of Task, though in opposite directions, for the two borderlines. For the A+G− case, Typicality scores were markedly <u>higher</u> than Categorisation scores (Typicality = 1.93, categorization = 1.03, $t(39) = 3.21$, $p < 0.01$) while for the A−G+ case, Typicality scores were markedly <u>lower</u> than Categorisation scores (Typicality = 0.83,

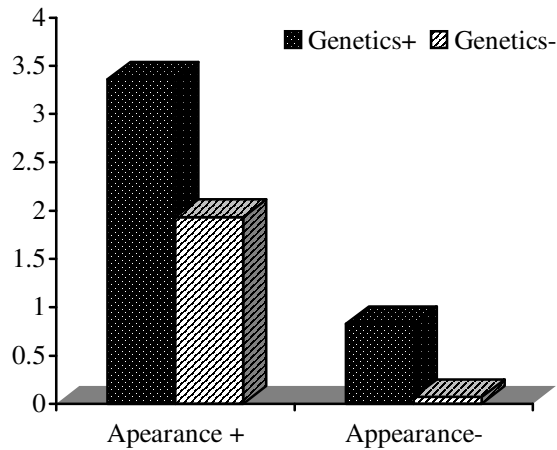Figure 2. Typicality ratings by Appearance and Genetics.

Figure 3. Categorisation ratings by Appearance and Genetics.

categorisation = 1.65, t(39) = 2.69, p < 0.05).

Both Thibaut et al. and Estes & Hampton found that SCDs were due to only a subset of participants dissociatin their judgments. To examine this possibility, the number of times each participant gave dissociated pairs of judgments for the borderline items was calculated. A dissociated pair of judgments was defined in terms of differences between typicality and categorization responses for two borderline items within the same category, where the differences in the scores have different sign. For example, a participant might rate an A+G− as more typical than an A−G+, but categorise the former negatively and the latter positively. Though the difference in typicality scores is positive, the difference in categorization will be negative. Dissociations were also defined to include cases where participants gave differing categorization responses to the two borderlines within the same category, but gave the same typicality judgments. Each of these types of dissociation undermines the suggestion that categorization is a function of similarity.

Of the 40 participants, 25 (63%) gave no dissociated pair of judgments to the four pairs of borderlines with which they were presented; however, 5 (13%) gave dissociated judgments to all four pairs of borderlines.

Discussion of Experiment 1

Although previous research has claimed evidence of such dissociations, largely these have been single dissociations, i.e., items for which categorization points to category A and similarity to category B. In contrast, the present research dissociates these judgments in two ways. First, for A+G− items, typicality scores are higher than their corresponding categorization scores. For A−G+ items, typicality scores are lower than the corresponding categorization scores. Moreover, A+G− items are judged more typical than A−G+ items (1.93
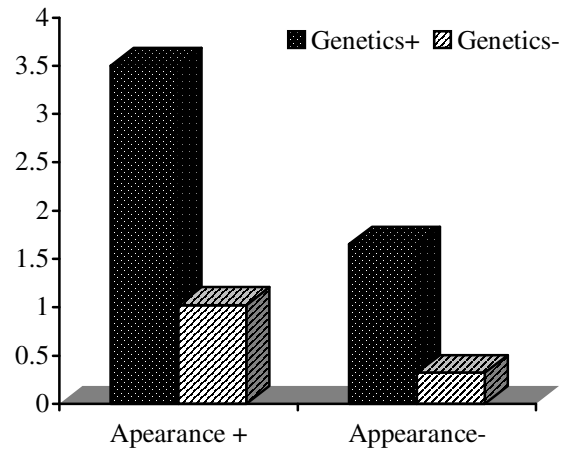
and 0.83 respectively, t(39) = 3.94, p < 0.001); yet A+G− items are judged less likely to be in the category than A−G+ items (1.03 and 1.65 respectively, t(39) = 1.73, p = 0.09). Taken together, these findings present a challenge for similarity-based models, for it should not be possible for an item A to be more typical than item B and yet less likely to be a category member than item B.

It should also be noted that these materials do not present participants with fantastical transformations or discoveries. Nor do they tap artificial categories. Moreover, these data do not provide support for the idea that dissociations arise only under an especially reflective mode of categorisation. Response times were collected for both typicality and categorisation judgments. Typicality is often taken to be an index of an initial similarity computation, which can be over-ridden by a subsequent reflective categorisation. However, the response times in this experiment provide no support for this thesis: typicality response times averaged 5.13 seconds (including the time taken to read each scenario), yet categorisation averaged 3.86 seconds (again including reading time), a statistically significant difference [t(39) = 5.40, p < 0.001].

Lastly, though, it should be noted that the dissociations arise because of a subset of the participants, corroborating the findings of Estes & Hampton, and Thibaut et al.

In spite of not supporting similarity-based models, there is the possibility that categorisation and similarity judgments may align in context. That is, when in a specific context, it may be that participants make similarity-based categorisations, and dissociations arise only because these judgments are elicited out of context. The next two experiments sought to investigate this possibility by eliciting judgments in contexts thought to emphasise either appearance or genetic

properties. Both require participants to adopt a perspective in making their categorisation and typicality judgments (cf. Barsalou & Sewell, 1984)

Experiment 2

This experiment sought to establish whether similarity and categorization judgments dissociate for the two kinds of borderline, A+G− and A−G+, when participants are asked to adopt a perspective that emphasizes appearance properties.

Design

Task (Typicality, Categorisation), Appearance (A+,A−) and Genetics (G+,G−) were within-participants factors.

Participants 33 undergraduate psychology students attending an Open University residential school volunteered to participate.

Materials The same categories in experiment 1 were used. Scenarios were as in experiment 1, but were prefaced by the clause "Imagine that you are a Sculptor…". It was assumed, based on previous work, that participants would take this profession to signal the enhanced relevance of appearance properties.

Procedure An identical procedure to experiment 1 was followed. However, categorization and typicality questions were prefaced by the clause "Imagining yourself to be a sculptor…".

Results

Responses to the categorization and typicality questions (transformed as before) were analysed using ANOVA with Task (Typicality, Categorisation), Appearance (+,−) and Genetics (+,−) as within-subject factors.

There was no effect of Task (p = 0.96), but main effects of Appearance [$F(1,32) = 325.18$, $p < 0.001$; $\eta^2 = 0.91$] and Genetics [$F(1,32) = 35.30$, $p < 0.001$; $\eta^2 = 0.53$], interactions between Task and Genetics [$F1,32) = 6.82$, $p < 0.05$; $\eta^2 = 0.18$] and between Appearance and Genetics [$F(1,32) = 4.23$, $p < 0.05$; $\eta^2 = 0.12$]. However, there was no three-way interaction between Task, Appearance and Genetics (p = 0.20). The interaction between Appearance and Genetics is shown in Figure 4.

Although no three-way interaction was found, pairwise comparisons were performed to examine the possibility that there might be differences between the Tasks for the two borderline items (since these were the source of the three-way interaction in experiment 1). Unlike experiment 1, there was no effect of Task for the A−G+ borderline, though there was a marginal effect for the A+G− borderline (Categorisation = 2.64, typicality = 3.17, $t(32) = 2.03$, $p = 0.05$).

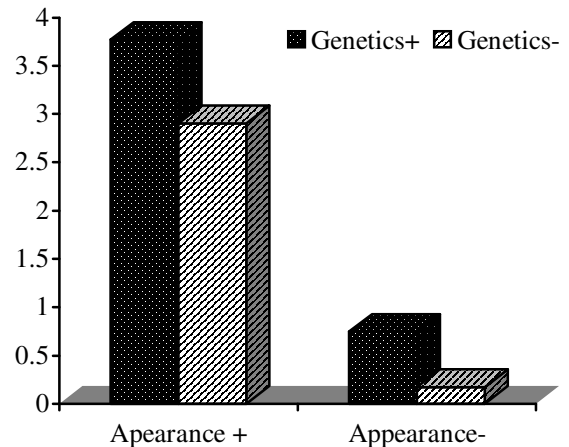As before, the response patterns of individual

Figure 4. Overall ratings by Appearance and Genetics under a 'Sculptor' perspective.

participants were examined to see how many gave dissociated judgments. Of the 33 participants, 23 (70%) gave no dissociated pair of judgments to the four pairs of borderlines with which they were presented; no participants gave dissociated judgments to all four pairs of borderlines.

Discussion of Experiment 2

Unlike experiment 1, these results provide no evidence of a dissociation between categorisation and similarity judgments. That is, the dissociation appears to have been eliminated by ensuring participants give their judgments from a specific perspective or context. The pairwise comparisons support this interpretation. Critically, the typicality and categorization scores do not violate the assumptions of similarity-based models: both A+G− and A−G+ cases differ in categorisation (2.64 and 0.94 respectively, $t(32) = 4.29$, $p < 0.001$) but also in typicality (3.17 and 0.56 respectively, $t(32) = 10.12$, $p < 0.001$). Hence the borderlines here do not provide evidence of dissociation – the increase in categorization is matched by an increase in typicality.

Experiment 3 seeks to establish whether the salience of genetic properties can be enhanced sufficiently to eliminate the dissociation in experiment 1.

Experiment 3

This experiment sought to establish whether similarity and categorization judgments dissociate for the two kinds of borderline, A+G− and A−G+, when participants are asked to make adopt a perspective that emphasizes genetic or biological properties.

Design

Task (Typicality, Categorisation), Appearance (A+,A−) and Genetics (G+,G−) were within-participants factors.

Participants 35 undergraduate psychology students

attending an Open University residential school volunteered to participate.

Materials The same categories in experiment 1 were used. Scenarios were as in experiment 1, but were prefaced by the clause "Imagine that you are a Biologist…". It was assumed, based on previous work, that participants would take this profession to signal the enhanced relevance of biological properties.

Procedure An identical procedure to experiment 1 was followed. However, categorization and typicality questions were prefaced by the clause "Imagining yourself to be a biologist…".

Results

Responses to the categorization and typicality questions (transformed as before) were analysed using ANOVA with Task (Typicality, Categorisation), Appearance $(+,-)$ and Genetics $(+,-)$ as within-subject factors.

The pattern of results from the ANOVA exactly replicates that of experiment 2. There was no effect of Task $(p = 0.53)$, but main effects of Appearance $[F(1,33) = 84.28, p < 0.001; \eta^2 = 0.72]$ and Genetics $[F(1,33) = 125.02, p < 0.001; \eta^2 = 0.79]$, an interaction between Task and Genetics $[F(1,33) = 13.93, p < 0.01; \eta^2 = 0.30]$ and between Appearance and Genetics $[F(1,33) = 7.86, p < 0.01; \eta^2 = 0.19]$. As in experiment 2, there was no three-way interaction between Task, Appearance and Genetics. The interaction between Appearance and Genetics is shown in Figure 5.

As in experiment 2, although no three-way interaction was found, pair-wise comparisons were performed to examine the possibility that there might be differences between the Tasks for the two borderline items. As before, there was no effect of Task for the A−G+ borderline, but an effect of Task for the A+G− borderline (Categorisation = 1.03, typicality = 1.72, $t(34) = 2.51, p < 0.05$).

19 participants (54%) gave no dissociated pair of judgments to the four pairs of borderlines with which they were presented; only 1 (3%) participant gave dissociated judgments to all four pairs of borderlines.

Discussion of Experiment 3

As in experiment 2, this experiment suggests that the dissociation between categorization and similarity judgments reported in experiment 1 can be eliminated when judgments are given under a specific perspective.

While the pairwise comparisons support this interpretation, other comparisons suggest that the perspective has not exerted such a strong influence in this experiment as in experiment 2. Overall, the typicality scores do not differ significantly for the two borderlines cases, A+G− and A−G+ (1.72 and 1.71 respectively, $p = 0.96$); however, the two borderlines do
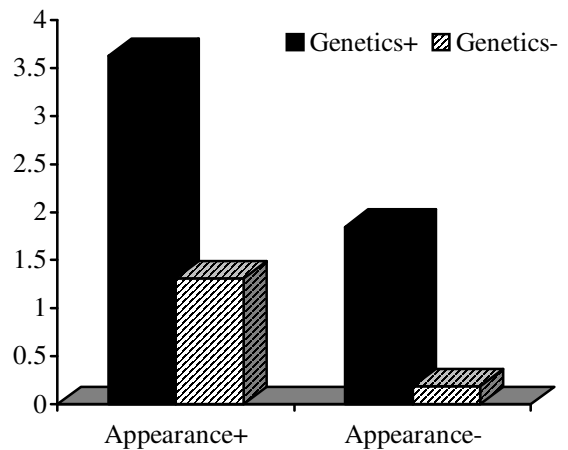

Figure 5. Overall ratings by Appearance and Genetics under a 'Biologist' perspective.

differ in their categorization scores: 1.03 and 2.09 respectively, $t(34) = 2.55, p < 0.05$). Hence the borderlines in this experiment provide evidence contrary to similarity-based models, i.e., an increase in categorization is not matched by an increase in similarity. Nevertheless, relative to experiment 1, the perspective has served to eliminate the differences in typicality between the borderlines, even though differences in categorization remain.

General Discussion

This paper provides evidence to support two main claims. The first is that similarity and categorization judgments dissociate for natural categories. The second is that such dissociations are perspective-dependent.

The data in experiment 1 reflect a double dissociation between similarity and categorization judgments, and serve to undermine similarity-based models of categorization. Though previous research has also uncovered dissociations, these have been single dissociations, and there have been difficulties in replicating those findings. Indeed, suggestions have been made that such dissociations arise only when categorization is highly reflective, only when designs are within-participant, and only for certain participants.

The data reported here contradict the first of these claims. That is, the categorization judgments obtained in these experiments have not been sought under a reflective mode – indeed response times show that participants take considerably less time to make these judgments than they do the corresponding typicality judgments. So, there is little evidence for these categorization judgments being particularly reflective.

These data confirm previous findings that dissociations arise because of a minority of participants. The data do not speak to the claim that dissociations

only arise in within-participant designs, although Thibaut et al.'s evidence contradicts such a claim. However, Thibaut et al.'s study arguably shows only that people can learn artificial categories for which similarity and categorization dissociations arise, not that these arise also for natural categories. This study appears to provide strong evidence that even for everyday, natural kind categories such dissociations arise. Moreover, the work presented here does not rely on identifying features that could be considered necessary or characteristic, a problem Thibaut et al. identify in previous work – indeed, the stimuli used here are defined without reference to particular features.

The second main claim is that by fixing perspective, dissociations between similarity and categorization judgments are reduced or eliminated. In experiment 2, making judgments from a 'sculptor' perspective eliminated the dissociation, whereas it was reduced in experiment 3.

How might these findings of perspective-dependence be explained? One possibility is that similarity-based models should be seen as models of categorization-in-context. Categorization and typicality judgments are often elicited out of context. Without the constraint of context, participants may call on different kinds of information to make the two kinds of judgment. In other words, models of categorization should first seek to model categorization-in-context and then attempt to explicate context-free categorization judgments. One possibility for such a perspectival account of concepts allows that categorization is similarity-based, but that the current perspective fixes the relevant dimensions to be used in the similarity computation (Braisby, 1998).

Another possible explanation is that in experiments 2 and 3, dissociations do not appear because the instructions used for categorization and similarity do not elicit those judgments. For example, it could be that both sets of instructions actually elicit a categorization judgment, and participants respond in the typicality task as best they can given that their judgment reflects a categorization, rather than an overt judgment of typicality. However, such an explanation is fraught with problems – for example, if conventional instructions do not determine the kind of judgment people make, then there is no obvious basis for deciding whether any previous research has really elicited categorization or typicality judgments.

In conclusion, the data reported here suggest that a simple similarity-based view of categorization is not right. However, when context is fixed, then the similarity-based models may fare much better. What is needed to augment such models is a mechanism by which the current perspective or context fixes the relevant dimensions on which categorizations and similarity judgments are made.

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