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Proceedings of the Annual Meeting of the Cognitive Science Society

Title
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Permalink
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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 34(34)

ISSN
1069-7977

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Publication Date
2012

Peer reviewed

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Categorisation in High and Low Schizotypes

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Abstract

Disorders provide an important source of information in developing theories of normal categorisation. Disruption in categorisation in individuals diagnosed with schizophrenia has been widely evidenced. However, findings are often contradictory and subject to significant confounds. In the present study 35 high schizotypes and 35 low scorers completed a semantic categorisation task and a borderline categorisation task, with measures of category membership judgment, similarity and response time being taken. Results revealed that high schizotypes made significantly fewer positive category membership judgments than low schizotypes (p = .003) and suggest that different theoretical explanations may be required to explain the categorisation of high and low schizotypes. Explanations in terms of theories of normal categorisation are developed.

Keywords: Concepts; Categorisation; Schizotypy; Essentialism; Semantic Processing.

Introduction

Disorders of categorisation are an important source of information in developing theories of normal categorisation. Work on category-specific impairment, for example, has led to the proposal that functional and appearance attributes are represented in concepts in different ways (cf. Strnad, Anzellotti & Caramazza, 2011).

Categorisation is known to be disrupted in other disorders, most notably dementia (Doughty et al., 2009), autism (Church et al., 2010), and schizophrenia (Doughty & Done, 2009), as well as in neuropsychological cases (Cohen, Johnston & Plunkett, 2000).

Schizophrenia has long been associated with the suggestion that categorisation is subject to over-inclusion, that category boundaries are shifted outward, incorporating into the category items that would normally be regarded as non-members (Lawrence, Doughty, Al-Mousawi, Clegg & Done, 2007). However, disorders also present difficulties for experimental investigations of categorisation. In the case of schizophrenia, for example, significant confounds are often present, such as hospitalisation, medication, psychosis, and attentional dysfunction. Perhaps unsurprisingly, and in spite of the prominence the suggestion of over-inclusion has received, relatively little is actually known of categorisation in schizophrenia. Moreover, the sparse evidence is often inconsistent or contradictory.

However, schizophrenia has been linked theoretically to schizotypy, a multidimensional construct that assumes healthy individuals may manifest subclinical presentations of schizophrenic symptoms. Schizotypy varies in degree along a continuum from such psychologically healthy individuals to those diagnosed with schizophrenia (Claridge, 1985). Those high in schizotypy are described as psychosis-prone, and may experience oddities of belief, behaviour, eccentricities, idiosyncratic speech, peculiar ideas, and social awkwardness or aversion at a subclinical level (Siever, Kalus & Keefe, 1993). High schizotypes have been studied in order to gain understanding of vulnerabilities to schizophrenia (Peters, Pickering & Hemsley, 1994). Indeed, in the presence of sufficient environmental stressors, the contention is that high schizotypes may develop schizophrenia, and present with appropriate clinical symptoms.

High schizotypes therefore provide the researcher with a compelling opportunity to examine 'disordered' cognition in an otherwise healthy population. However, there have been relatively few studies of categorisation in high and low schizotypes, and what data there are appear inconsistent.

Semantic Processing in Schizophrenia

Abnormalities in semantic processing are thought to be central to cognitive abnormalities in schizophrenia, with deficits reported on a wide variety of semantic processing tasks (Chen, Wilkins & McKenna, 1994). Further, semantic deficits are suggested to underlie disturbances in thought and language in schizophrenia, which might not only explain deficits observed in other cognitive domains, but also provide a cognitive explanation for common symptoms in schizophrenia, such as delusions (Rossell, Rabe-Hesketh, Shapleske & David, 1999) and thought disorder (Gouzoulis-Mayfrank et al., 2003).

Semantic Processing in Schizotypy

Although impairments in attention (Lenzenweger, Cornblatt & Putnick, 1991) and executive functioning (Suhr, 1997; Tallent & Gooding, 1999) have been found in schizotypy, few studies have addressed the relationship between schizotypy and semantic processing. Those that have done so have used semantic priming tasks (Beech, McManus, Bayliss, Tipper & Agar, 1991; Morgan, Bedford & Rossell, 2006) and revealed differences between high and low schizotypes (Morgan et al., 2006).

However, there has been little research on other areas of semantic processing in schizotypy, Morgan, Bedford, O'Reagan & Rossell (2009) being a notable exception. Very few studies of schizotypy have included categorisation tasks and none have made categorisation a primary focus.

Categorisation in Schizotypy

The majority of studies on categorisation in schizotypy have used fluency tasks whereby participants are asked to generate exemplars given a category label (Barrantes-Vidal et al., 2003; Duchene, Graves & Brugger, 1998; Kiang & Kutas, 2005). Fluency tasks are typically used to make estimates of the semantic distance between pairs of concepts. Although these provide a measure of the organisation of semantic information, they do not address the process of categorisation directly. Categorisation tasks, which require participants to make category membership judgments, have been used in only two studies (Kiang & Kutas, 2005; Morgan et al., 2009).

Kiang & Kutas (2005) presented their participants with a category definition followed by exemplars of varying typicality and required them to judge whether or not each was a category member. In their EEG study, no group differences were found in the N400 component, although they did report a negative correlation between schizotypy score and ERP amplitude differences between category members and non-members.

Morgan et al. (2009) asked participants to rate the category membership of exemplars of varying degrees of relatedness. Group differences were found only for low frequency items, with high schizotypes regarding low frequency exemplars as belonging less to the category than did low schizotypes. Differences in the same direction were reported as nearing significance for high frequency category members and borderline exemplars.

Surprisingly, the authors did not comment on the contrast between this apparent 'under-inclusion' and the over-inclusion reported in schizophrenia. Indeed, despite the suggestion that in schizophrenia categories are over-included, there has been very little focus on this question in relation to schizotypy. It is unclear whether differences in categorisation between high and low schizotypes are generally not reliable, or whether previous studies have not been sufficiently sensitive to detect them.

Categorising Borderlines

Previous investigations of schizotypy have not examined the relative contribution of different attributes to categorisation. Yet characteristic and necessary features (cf. Rips, Shoben & Smith, 1973) allow for the creation of two borderline cases: exemplars with characteristic but not necessary features and exemplars with necessary but not characteristic features. Similar cases have been used in previous research, for example, in debates as to whether categorisation is similarity- or theory-based (e.g. Rips, 1989).

This study therefore consists of two tasks: a replication of the semantic categorisation task reported by Morgan et al. (2009) with the additional measures of response times, and similarity ratings to better gauge whether categorisation in schizotypy is characterised by over- or under-inclusion; and a borderline categorisation task using two types of borderline exemplars, as above, for artefact and natural kind categories, with measures of categorisation and similarity judgments, and response times, in order to shed light on the ways in which category boundaries might be shifted.

Experiment

Method

Design

The study employed two tasks. In both, dependent variables were categorisation (member, non-member), similarity rating (1-7), and response time (ms).

Semantic categorisation This employed a 2 x 5 design with one between-participants factor (Group [low, high]) and one within-participants factor (Relatedness [high frequency, low frequency, borderline, related but outside of the category, unrelated]).

Borderline categorisation This employed a 2 x 2 x 2 x 3 design with one between-participants factor (Group [low, high]) and three within-participants factors (Appearance [+, -], Essence [+, -] and Category [artefact, food natural kinds, non-food natural kinds]).

Participants

Two hundred and seventy eight participants were screened using an online questionnaire, the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE: Mason, Claridge & Jackson, 1995). Scores from the questionnaire were used to determine high and low groups: high group (n = 35), above the 70th percentile ($\geq$ 44) and the low group (n = 35), below the 30th percentile ($\leq$ 29). The high group consisted of 6 males and 29 females with a mean age of 25.83 (SD = 9.39) and the low group consisted of 9 males and 26 females with a mean age of 27.54 (SD = 11.37).

Materials

O-LIFE The O-LIFE is a 159-item questionnaire based on the Combined Schizotypal Traits Questionnaire (Bentall et al., 1989) and is used to measure schizotypy. The O-LIFE yields 4 factors: unusual experiences (e.g. 'Do you think that you could learn to read other's minds if you wanted to?'), cognitive disorganisation (e.g. 'Are you easily confused if too much happens at the same time?'), introvertive anhedonia (e.g. 'Are there very few things that you have ever enjoyed doing?'), and impulsive nonconformity (e.g. 'Do you at times have an urge to do something harmful or shocking?').

Semantic categorisation The semantic categorisation task replicates and extends the task reported by Morgan et al. (2009). They had selected eighteen categories from the norms of Battig and Montague (1969) and of Hampton and Gardiner (1983): body parts, clothing, drinks, flowers, food flavouring, furniture, insects, instruments, mammal, metal, part of building, professions, reading material, sport, tools, type of cloth, vehicle, and weapon. For each category,

Morgan et al. (2009) identified 5 different exemplars of differing degrees of relatedness, resulting in 90 trials, as follows: (1) high frequency (e.g. leg for the category 'body part'), (2) low frequency (e.g. thumb), (3) borderline (e.g. joint), (4) related but outside the category (e.g. wig), and unrelated (e.g. cricket). To extend the replication, response times (ms) and similarity ratings were also measured.

Borderline categorisation Based on Braisby (2004), this task employed three types of category (food natural kinds, non-food natural kinds and artefacts), with 4 different categories for each: apple, chicken, potato and salmon for food natural kinds; canary, dog, oak tree and rose for non-food natural kinds; and car, fork, piano and sailboat for artefacts. For each category, 4 different exemplars were described, defined by the presence or absence of appearance and essence properties, resulting in 48 trials. Exemplars were presented in scenarios and were defined by having: (1) appearance properties absent, essence properties absent (A-E-), (2) appearance properties absent, essence properties present (A-E+), (3) appearance properties present, essence properties absent (A+E-), and (4) appearance properties present, essence properties present (A+E+). The following is an example of how stimuli were presented in scenario form for the category 'apple', for the exemplar type (A+E-).

'You have just acquired an apple. You discover that it has been genetically modified so that it has NONE of the genetic properties specific to apples. Upon examination, you find that it looks, feels, smells and even tastes JUST like an apple.'

For natural kind categories, essential properties were expressed in terms of possession of the genetic properties specific to the category; for artefacts, these were expressed in terms of the original intended function (cf. Bloom, 1996).

Procedure

Participants completed both tasks and stimuli were presented and responses recorded using E-Prime (Schneider, Eschman & Zuccolotto, 2002). The order of tasks was counterbalanced.

Semantic categorisation Participants were required to read the exemplar and category names and make a similarity judgment, and then a category membership judgment (Yes or No). Practice examples were used.

Borderline categorisation The scenario appeared on screen and participants were required to make a similarity judgment, and then a category membership judgment (Yes or No). Practice examples were used.

Results

For both semantic categorisation and the borderline categorisation task, category membership judgments were scored 1 for a 'yes' response and 0 for a 'no' response. For the borderline categorisation task, category membership judgments, category membership judgment response times, similarity ratings and similarity rating response times were all averaged over the four categories belonging to each superordinate category.

A series of 2 x 5 ANOVAs were conducted to examine category membership judgments, category membership judgment response times, similarity ratings and similarity rating response times.

Semantic Categorisation

Critically, no group differences were found for measures of category membership judgment, similarity judgment or response times, nor did any approach significance (all $p > .3$). Thus Morgan et al.'s (2009) key finding of group differences for low frequency items was not supported.

Consistent with their findings, however, the main effect of relatedness was significant for category membership judgments [$F(2.82, 191.80) = 1613.00$, $p < .001$, partial $\eta^2 = .96$] and similarity ratings [$F(2.52, 171.27) = 1558.00$, $p < .001$, partial $\eta^2 = .96$], with both ratings increasing with semantic relatedness (see Figure 1).

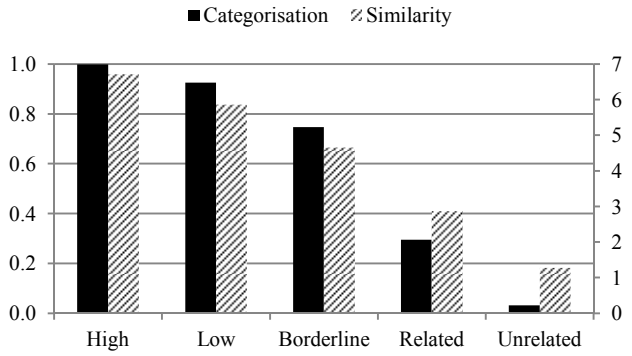


Figure 1. Mean proportion of positive category judgments (left axis) and mean similarity ratings (right axis) for each level of relatedness.

Examining response times, as expected, the main effect of relatedness was also significant for category membership judgments [$F(2.74, 186.32) = 17.22$, $p < .001$, partial $\eta^2 = .20$] and similarity ratings [$F(3.37, 229.10) = 43.91$, $p < .001$, partial $\eta^2 = .39$]. These results support previous findings with categorisation response times following an inverted V-shaped function: response times increase as the semantic distance between the category and the exemplar increases to the boundary, and decrease with increasing semantic distance (Rips et al., 1973).

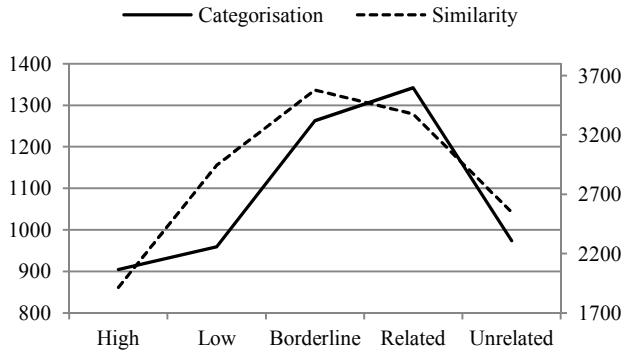


Figure 2. Mean category judgment (left axis) and similarity rating (right axis) response times (ms) for each level of relatedness.

Borderline Categorisation

A series of 2 x 2 x 2 x 3 ANOVAs were conducted to examine category membership judgments, category membership judgment response times, similarity ratings and similarity rating response times.

Category membership judgments Critically, the main effect of group was significant [$F(1, 68) = 9.52$, $p = .003$, partial $\eta^2 = .12$], with high schizotypes providing significantly fewer positive category membership judgments ($M = .43$) than low schizotypes ($M = .52$).

The category by appearance interaction was significant [$F(1.70, 115.31) = 12.03$, $p < .001$, partial $\eta^2 = .15$, Huynh-Feldt corrected here and elsewhere] and contrasts revealed significant interactions when comparing artefacts to food natural kinds [$F(1, 68) = 15.48$, $p < .001$, partial $\eta^2 = .19$] and artefacts to non-food natural kinds [$F(1, 68) = 13.80$, $p < .001$, partial $\eta^2 = .17$]. The effect of appearance properties was greater for food (0.44) and non-food (0.43) natural kinds than it was artefact categories (0.29).

The category by essence interaction was also significant [$F(1.68, 113.98) = 30.04$, $p < .001$, partial $\eta^2 = .31$]. Contrasts revealed significant interactions when comparing artefacts to food natural kinds [$F(1, 68) = 41.50$, $p < .001$, partial $\eta^2 = .38$], and artefacts to non-food natural kinds [$F(1, 68) = 31.31$, $p < .001$, partial $\eta^2 = .32$]. The effect of essence properties was greater for artefact categories (0.68) than both food (0.43) and non-food (0.46) natural kinds.

Similar effects were obtained for similarity ratings. Taken together, these results imply that overall participants essentialised artefact categories more strongly than they did the food or non-food natural kinds, for which the influence of appearance properties was equally strong.

There was a significant three-way interaction between appearance, essence and group [$F(1, 68) = 8.02$, $p = .006$, partial $\eta^2 = .11$]. Pairwise comparisons revealed differences nearing significance between the high group ($M = .895$, $SE = .038$) and low group ($M = .974$, $SE = .015$) for [A+E+] exemplars [$t(68) = 1.94$, $p = .059$, $r = .23$] and between the high group ($M = .462$, $SE = .062$) and the low group ($M = .621$, $SE = .059$) for [A-E+] exemplars [$t(68) = 1.88$, $p = .064$, $r = .22$]. Pairwise comparisons between the high group ($M = .352$, $SE = .056$) and low group ($M = .462$, $SE = .062$) for [A+E-] exemplars were not significant [$t(68) = 1.31$, $p = .196$, $r = .16$]. Thus, the low schizotypes tended to give a higher proportion of positive categorisation judgments than high schizotypes when essence properties were present. However, these conclusions must be tempered due to the possibility of a floor effect (i.e. in the [A-E-] condition).

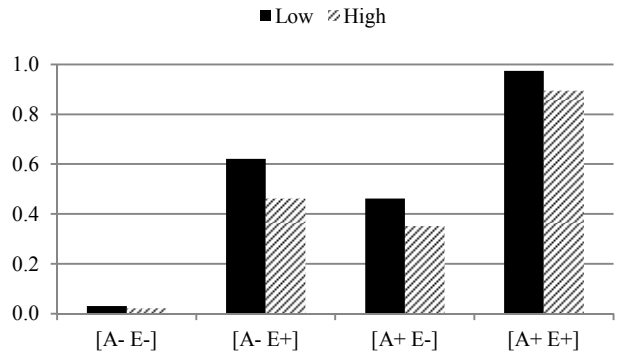


Figure 3. Three-way interaction between appearance, essence and group. Mean proportion of positive category judgments are shown for each exemplar type.

The three-way interaction between category, appearance and group was also significant [$F(1.70, 115.31) = 3.84$, $p = .031$, partial $\eta^2 = .05$]. Contrasts revealed a significant difference between the high and low group when comparing artefacts to food natural kinds [$F(1, 68) = 6.31$, $p = .014$, partial $\eta^2 = .09$]. High schizotypes (0.34) were more influenced by appearance properties than low schizotypes (0.24) when categorising artefacts. However, low schizotypes (0.49) were more influenced by appearance properties than high schizotypes (0.39) in categorising food natural kinds.

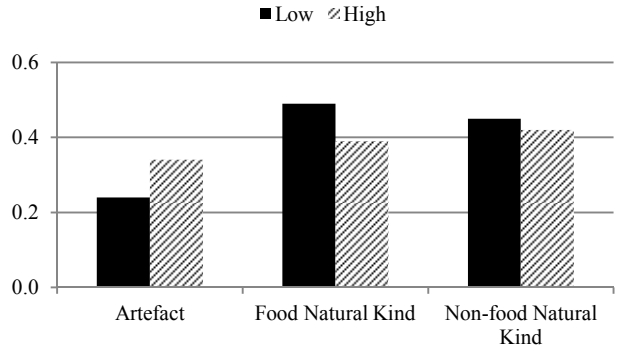


Figure 4. Effect of appearance properties (A+ minus A-category membership judgments) for high and low group, artefact, food natural kind and non-food natural kind categories.

Category judgment response times Importantly, the main effect of group was not significant [$F(1, 68) = .54$, $p = .465$, partial $\eta^2 = .008$] suggesting that the difference in categorisation judgments does not stem from a speed-accuracy trade-off. The category by group interaction was significant [$F(1.91, 129.53) = 3.40$, $p = .039$, partial $\eta^2 = .048$]. Contrasts revealed a significant interaction when comparing the high schizotypy group and low group response times for the artefact and the non-food natural kind categories [$F(1, 68) = 5.27$, $p = .025$, partial $\eta^2 = .072$]. For the artefact category, response times were similar for the low group and the high group, however for the non-food natural kinds category response times decreased for the high group and increased for the low group. Pairwise comparisons revealed differences nearing significance between artefact categories ($M = 1508$, $SE = 126.3$) and non-food categories ($M = 1895$, $SE = 215.6$) for the low group [$t(34) = -1.98$, $p = .056$, $r = .32$], while those between artefact categories ($M = 1612$, $SE = 203.5$) and non-food categories ($M = 1492$, $SE = 178.5$) for the high group were not significant [$t(68) = 1.18$, $p = .247$, $r = .20$].

Similarity ratings The main effect of group was not significant [$F(1, 68) = .008$, $p = .928$, partial $\eta^2 = .000$] nor were there any significant interactions involving group.

Discussion

The current research aimed to explore over- or under-inclusion in categorisation in schizotypy by (a) utilising more sensitive measures of categorisation (i.e. similarity ratings and response times) than in previous studies and (b) utilising borderline exemplars.

Semantic Categorisation

Kiang and Kutas (2005) used only high and low frequency, and unrelated exemplars, and found no group differences. Morgan et al. (2009) used similar stimuli, taken from similar norms (Battig & Montague, 1969; Hampton & Gardiner, 1983), as well as borderline and related exemplars, and found group differences. The present study found no group differences, and so it remains unclear where the locus of any group difference, if such exists, might lie.

Borderline Categorisation

In contrast, the borderline categorisation task provides some limited support for the findings by Morgan et al. (2009). Consistent with their findings, high schizotypes provided significantly fewer positive category judgments than the low group – that is high schizotypes show evidence of under-inclusion. It is possible that the semantic categorisation task is too insensitive to reliably reveal group differences, and that the borderlines task, which focuses attention on cases whose categorisation is uncertain, is more sensitive.

That the group difference appears localised to exemplars possessing essential properties suggests that low schizotypes may be more essentialist, making positive category judgments more readily when essential properties are present. For both groups, the effect of appearance properties was greater for natural kinds than it was for artefact categories, and the effect of essence properties was greater for artefact categories than for natural kinds. At least for these participants and these stimuli, the artefact categories appear to be more strongly essentialised.

Finally, it is interesting that no group differences emerged in response times on the semantic categorisation task. Morgan et al. (2009) reported that they may have revealed group differences as they used shorter SOAs than Kiang and Kutas (2005), thus increasing task demands. It is possible that increasing the demands of the semantic categorisation task would render it more sensitive to group differences.

The data support previous findings that have shown an inverted V-shaped function in categorisation times (Chen et al., 1994; Rips et al., 1973). Again, no group differences were noted, suggesting that group differences in categorisation in the Morgan et al. (2009) study were not due to high schizotypes requiring more time to categorise.

Explaining Group Differences

As indicated, one possible explanation for the fact that high schizotypes provided fewer positive category judgments than the low group, and fewer positive category judgments for both types of borderline exemplar, is that they weighed less heavily the presence of essential properties. Alternatively, they may have operated with a stricter definition or higher threshold for category membership than low schizotypes, with the categorisation of high schizotypes being more similarity-based.

Essence properties were only present in the [A-E+] borderline exemplars and on this basis these exemplars should have received more positive category membership judgments if participants were essentialist. As noted above, it appears as though artefact categories were more strongly essentialised. It also appears as though the low group were more essentialist, as [A-E+] borderlines were categorised more positively by the low than by the high group.

Of course, as this is one of the few studies to directly examine the relationship between schizotypy and categorisation, these data are unlikely to be decisive as regards extant theories of concepts. Further work is needed to confirm these findings, possibly including meta-analytic studies that offer the prospect of considerably greater statistical power. Nevertheless, it is possible that the categorisation of high and low schizotypes may require somewhat different theories, with those of high schizotypes being more similarity-based, and those of low schizotypes being more essentialist. Although the current study is not able to adjudicate between different theoretical frameworks, it does suggest the promise of further studies of schizotypy and categorisation in helping to do so.

Acknowledgements

Our thanks go to the many participants who gave their time to take part in this research, and to Mercè Prat-Sala for helpful comments on earlier versions of this research.

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