THE SEMANTIC ORGANISATION OF MASS NOUNS: EVIDENCE FROM SEMANTIC REFRACTORY ACCESS DYSPHASIA

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Abstract

The conceptual properties and organisation of mass noun concepts are examined in a patient (A.Z.) with a semantic refractory access disorder. A cardinal feature of this class of disorder is the build up of interference (refractoriness) between semantically similar concepts. In a series of written word identification tasks, a gradient of semantic relatedness is demonstrated within the broad domain of mass noun concepts but not between different word classes. More detailed examinations of semantic similarity effects within subcategories of mass concepts reveal a variable degree of fine-grain organisation, which may reflect the influence of premorbid personal knowledge and experience. Furthermore, it is demonstrated that common mass or count noun status did not lead to an enhancement of the refractory effects of semantic similarity.

Key words: mass/count nouns, comprehension, stroke, semantic refractory access dysphasia

INTRODUCTION

In recent years, the study of categorical aphasic deficits arising from neurological damage has been strongly biased towards trying to understand the organisation of conceptual knowledge relating to concrete objects such as animals, plants and manmade artefacts (for a review see Capitani et al., 2003). However, other categorical distinctions that are potentially of equal importance have received far less investigative attention, such as the division between mass nouns and count nouns. Semantically, mass nouns are those items which have no firm perceptual boundaries and which in combination constitute a larger version of the same substance (e.g., water, wood, coal), whilst count nouns are those items which do have a perceptual form but which in combination do not represent the same entity (e.g., cat, sock, pear). Grammatically, mass nouns cannot be pluralized, preceded by an indefinite article or counted, whilst count nouns can be pluralized, do take both the definite and indefinite article and can be counted.

Under such definitions, it can be seen that the majority of semantic category specific disorders reported concern items falling within the domain of count nouns. However, within this literature some attention has been given to so-called sensoryquality items which include mass terms (e.g., materials, liquids, edible substances) as well as count terms (e.g., animals). Proponents of the traditional sensory/functional theory of category specificity have used evidence of concomitant deficits across sensory-quality items relative to spared comprehension and naming of artefact items to argue that sensory rather than functional information is central to the conceptual representation of both mass and count-type sensory-quality items (Borgo and Shallice, 2001, 2003). Irrespective of this particular theoretical interpretation however, such fine-grain category specific effects may suggest that either mass and count nouns have separable neural bases or that the mass/count distinction has little relevance at the level of conceptual knowledge.

Evidence of dissociations between mass nouns and count nouns has been reported at the level of syntactic, and arguably lexical semantic, processing (e.g., Semenza et al., 1997, 2000; Mondini et al., 2004; Taler et al., 2004). For example, Semenza et al. (1997) have reported a patient who, in the context of otherwise intact grammar, showed a selective deficit for the use of the grammatical properties of mass nouns. This deficit was demonstrated on a range of tasks including sentence completion, sentence production and judgements on the grammatical correctness of sentences, but notably not on tasks such as naming to definition, semantic judgement or semantic association. Reports of this type could be taken as supporting the view of Bunt (1976) that "the mass/count distinction is not really a distinction between words, but a distinction between ways of using the words". Nonetheless, there remains debate over whether the information underlying the differences between mass and count nouns is primarily semantic (e.g., Jackendoff, 1991; Wisniewski et al., 1996) or syntactic in nature (e.g., Gillon, 1992; Vigliocco et al., 1999). It should be noted that this debate is not exclusive, with many linguists holding that the distinction has both semantic and syntactic bases. However, the

role of "semantic" information in this sense corresponds to lexical semantic information rather than purely conceptual information. In many information processing models, this distinction between lexical semantic and general semantic information corresponds to the distinction between the semantic component of a lemma level representation and a more general knowledge base, which lies prior to lemma level representations.

Despite the fact that the debate concerning the count/mass nouns primarily has its roots in the psycholinguistic rather than conceptual knowledge literature, it remains of interest to examine whether some essence of the mass/count distinction is represented at the conceptual level, rather than simply presume it unlikely. Such an examination would be justified and of interest for several reasons. First, a number of authors have postulated that the mass/count distinction is represented not only at the syntactic level but also at the conceptual level; early in development, children are held to be able to distinguish solid, shape-invariant items from the materials from which they are constituted, and moreover to know that different properties define object and substance categories (Soja et al., 1991; Soja, 1992). However, it is not known whether such early conceptual differentiation may persist and constitute a significant principle of conceptual organisation in the adult brain. Secondly, not all researchers accept the notion of separate conceptual and lexical semantic representations (e.g., Caramazza, 1997; Cipolotti, 2000). Thus, any evidence of a semantic basis to what many consider to be a syntactic distinction would have implications for theories of language production.

In this report, an attempt is made to address some of these issues by examining the ability of a patient (A.Z.) with a semantic refractory access disorder to comprehend and identify mass and count nouns. Semantic refractory access disorders are characterised by a sensitivity to temporal factors, with the conceptual system requiring time to regain a resting level of activation following use (Warrington and McCarthy, 1983, 1987). Semantic distance effects are also commonly observed, which are attributed to the effect of refractoriness not only upon the subsequent re-activation of a given representation but also other representations that share semantic space (Crutch and Warrington, 2003, 2004). Importantly, semantic distance effects can be observed both on word-picture matching tasks and on tasks conducted entirely within the verbal domain, namely spoken word-written word matching. For example, the current patient, A.Z., has previously shown significantly higher error rates identifying written brand names presented in semantically related arrays (e.g., same product type: Vauxhall, Rover, Honda, Ford) than when the same items were presented in semantically unrelated arrays (e.g., Vauxhall, Asda, Nestle, Sony) (Crutch and Warrington, 2004). Thus, such

refractory access patients provide the opportunity to investigate fine-grain aspects of conceptual organisation and, in the current study, to examine the spread of refractoriness within syntactic and mass noun categories. Furthermore, we consider whether refractoriness is enhanced by common mass/count noun status.

CASE DESCRIPTION

The patient described, A.Z., is a 72-year-old housewife who was admitted to Northwick Park Hospital in January 2002 following a left middle cerebral artery stroke. The prominent presenting feature was a severe expressive and mild receptive dysphasia. Her spoken output was characterised by a fluent semantic and phonemic jargon. A CT scan conducted at the time of admission revealed damage to a large portion of the left middle cerebral territory, sparing the basal ganglia. The left parietal, temporal and posterior frontal regions were all affected.

Following the vascular incident, A.Z. became almost entirely anomic, naming only two items from the Boston Naming Test. A.Z. also exhibited a profound dyslexia and dysgraphia, reading correctly only 1/99 items taken from the Patterson and Hodges (1992) corpus. Word repetition skills were somewhat better preserved, correctly repeating 39/99 items from the same word pool. Auditory lexical decision performance was also relatively well preserved (71/80; PALPA 5) (Kay et al., 1992). Comprehension was assessed on the Pyramids and Palm Trees test for both word-word matching and picture-picture matching, and A.Z. showed a moderate impairment on both forms of the task (38/52 and 38/52, respectively). Furthermore, A.Z. gained comparable scores on the spoken word-picture and written word-picture matching versions of the British Picture Vocabulary Scale (22/32 and 21/32, respectively).

A.Z.'s comprehension performance was also observed to be both inconsistent and sensitive to temporal factors. These aspects of her comprehension deficit have been the focus of several previous investigations (Crutch and Warrington, 2003, 2004; Warrington and Crutch, 2004) in which it has been argued that A.Z. exhibits a semantic refractory access disorder. Central to our claims that A.Z.'s refractory access deficit was localised to a semantic and not presemantic level of processing was an experiment reported in Warrington and Crutch (2004). Pictures of 69 items were arranged into both 23 semantically related triplet arrays (e.g., goat, bear, deer) and 23 semantically unrelated but phonologically related (rhyming) triplet arrays (e.g., goat, boat, coat). The tasks was administered as a spoken word-picture matching task with items in all arrays being probed three times in a pseudorandom order. Despite the phonological similarity of items in the semantically unrelated condition, A.Z.'s performance was significantly more accurate than in the semantically related condition. This result was interpreted as demonstrating that at least a significant proportion of A.Z.'s refractory deficit could be localised to a semantic stage of information processing. This interpretation is particularly relevant in the present paper as the purpose of Experiment 1 was to constrain further our hypothesising about the information processing stage at which refractoriness is seen to act in this patient.

EXPERIMENTAL INVESTIGATIONS

Experiment 1 The Locus of the Refractory Access Deficit: A Parts of Speech Effect?

As noted in the Case Description, previous reports of the current patient have provided empirical evidence that the refractory access deficit has a semantic and not a pre-semantic locus. The aim of this experiment was to localise further this deficit, and in particular to attempt to establish whether syntactic information or only conceptual information influences the build up of refractoriness when this patient attempts spoken word-written word matching tasks.

Procedure

The stimuli consisted of 32 words: 8 nouns, 8 adjectives, 8 adverbs and 8 verbs (two of which could unfortunately also be classified as nouns). These stimuli were arranged into 8 arrays each containing four words from the same part of speech (e.g., all nouns). The same stimuli were also arranged into 8 arrays each containing four words which took a different part of speech (i.e., 1 nouns, 1 adjective, 1 adverb and 1 verb) (see Appendix I). With only very minor exceptions, the four words within each array had little or no semantic relationship between them. The task was presented as a spoken word-written word matching procedure, with the identity of every word in each array being probed four times in a pseudorandom order. A natural presentation rate of a 1 sec response-stimulus interval (RSI) was adopted. The same and different parts of speech arrays were administered in a counterbalanced design.

Results

A.Z. showed no difference in response accuracy between the same part of speech and different parts of speech conditions (same = 97/128, different = 94/128; χ^2 = .19, p > .6, df = 1).

Comment

The absence of an effect of parts of speech upon A.Z.'s accuracy in identifying stimulus words in this experiment provides empirical evidence which is useful with regard to establishing the locus of the refractory disorder in information processing terms. If the refractory disorder was affecting a level of processing at which information about the syntactic status of words was represented, then one would predict an effect of syntactic similarity akin to the semantic similarity effects which are observed so readily in this patient. The absence of such a syntactic similarity effect suggests that this type of information is not represented sufficiently strongly at the level at which refractoriness is occurring for a difference in the size of refractory effect to be observed. Although this negative result does not rule out the possibility of some refractoriness occurring among pure either syntactic or lemma level representations, the evidence is most compatible with a predominant localisation of the refractory deficit to the central conceptual system.

Experiment 2 Multiple Levels of Semantic Distance within the Mass Noun Domain

The influence of semantic relatedness upon the comprehension abilities of semantic refractory access patient A.Z. has previously been explored in the broad domains of common count nouns and proper nouns. However, semantic distance effects contingent upon refractoriness have not been examined or observed in the broad domain of mass nouns. In this experiment, the semantic organisation of a range of mass noun concepts was probed.

Procedure

The test stimuli consisted of 27 written mass nouns which were arranged into 9 semantically close arrays each containing three items drawn from the same category (e.g., gases, liquids, solids, meats, carbohydrates, alcoholic drinks, metals, stones, jewels). The same items were also arranged into 9 semantically intermediate triplet arrays containing either 3 chemicals (i.e., 1 gas, 1 liquid, 1 solid), 3 foodstuffs (i.e., 1 meat, 1 carbohydrate, 1 alcoholic drink) or 3 minerals (i.e., 1 metal, 1 stone, 1 jewel). Finally, the items were arranged into 9 semantically distant arrays each consisting of three items drawn from a different broad semantic category (e.g., 1 chemical, 1 foodstuff, 1 mineral). A full list of stimuli is provided in Appendix II.

The experiment was conducted as a spoken word-written word matching task, with the patient being requested to point to target written words in response to the examiner's presentation of corresponding spoken words. For each array, a



Fig. 1 – Performance on the variable semantic distance of mass nouns task (Experiment 2). (A) The percentage correct scores for the semantically close, intermediate and distant arrays. (B) The number of errors made on consecutive probes of the test stimuli, both for each individual semantic distance condition and the combined total error score.

repetitive testing procedure was adopted such that every item was probed four times in a pseudorandom order. Thus there were 12 responses per 3-item array. A natural presentation rate was used with a 1 sec pause between each pointing response and the presentation of the subsequent spoken word target (RSI). The arrays for each of the three conditions were presented in a serial ABC ABC design, and were ordered so that no individual word appeared in consecutive arrays.

Results

The percentage correct responses for the three conditions are shown in Figure 1A. A Friedman test showed a significant difference in the number of errors made in the three conditions ($Xr^2 = 7.18$, p < .05, df = 2). Referring to Figure 1A, it can be observed that this significant between-conditions effect reflects a deterioration in A.Z.'s performance level the closer the semantic relationship between stimuli within an array. The number of errors committed on each of the four serial probes was

calculated and is shown in Figure 1B. Cochran Q tests demonstrated a significant difference in response accuracy between probes for the semantically intermediate arrays (Q = 13.0, p < .01, df = 3) which reflects the gradual increase in the error rate across successive probes. However, such an effect was not observed with either semantically close or semantically distant arrays (Q = 3.36, p > .3 and q = 2.0, p > .5 respectively; df = 3 both).

Comment

These results indicate that there is a gradient of semantic relatedness within the broad domain of mass nouns. This gradient can be attributed to a greater degree of refractoriness among mass nouns which have a strong semantic relationship than among those which do not. Extraneous variables such as word frequency and age of acquisition cannot account for the semantic effect because exactly the same words were used in each condition, merely arranged into different combinations.

Experiment 3 Semantic Relatedness Effects among Categories of Mass Nouns

The semantic relatedness effect observed in the previous experiment provides evidence of a broad level of categorical organisation among the semantic representations of mass noun concepts. However, this observation was partly based on a comparison of A.Z.'s ability to identify items from the same narrow category with items drawn from across very different categories (i.e., the 'semantically distant' arrays were in fact 'very distant'). In this experiment, an attempt was made to identify finer-grain principles of organisation *within* particular semantic categories.

Procedure

The experiment was conducted in three separate parts using three different sets of experimental stimuli:

Set 1: 16 food names, 4 drawn from each of four classes of foods, namely meats (e.g., pork, lamb, beef, veal), cheeses, desserts and sauces (see Appendix III).

Set 2: 16 drink names, 4 drawn from each of four types of drink, namely long alcoholic drinks (e.g., lager, beer, cider, shandy), spirits, hot drinks and mixers (see Appendix IV).

Set 3: 16 names of non-edible solids, 4 drawn from each of four classes of solids, namely metals (e.g., iron, copper, steel, lead), stones, heavy fabrics and light fabrics (see Appendix V).

Each set of words was arranged into four semantically close written word arrays. The same stimulus words were also arranged into four semantically distant arrays containing one item from each of the four semantically close arrays within that set (e.g., distant foods: pork, stilton, custard, vinegar) (see Appendices III-V). A spoken wordwritten word matching paradigm was employed for each set of words. For each array, all the items were probed four times in a pseudorandom order. A 1 sec RSI was adopted, and within each set, close and distant arrays were presented in an ABAB BABA design. The three parts of the experiment were conducted separately, with the food and drink sets being administered on the same day and the nonedible solids four weeks later.

Results

The percentage correct responses in the semantically close and semantically distant conditions of the food, drink and non-edible solid experiments are shown in the leftmost portions of Figures 2A-2C. Wilcoxon matched-pairs ranked-sums tests revealed A.Z. was significantly less accurate in identifying foods when their names were presented in semantically close rather than

semantically distant arrays (z = 2.80, p < .01). However, no such effects of semantic similarity were observed in the identification of the names of drinks or non-edible solids (z = .40, p > .6 and z =1.08, p > .2). Serial position curves showing the percentage error rate on each consecutive probe of the stimulus items in each set are also presented in the right-hand portion of Figures 2A-2C. Cochran Q tests were employed to demonstrate a significant difference in the number of errors committed on each probe of the food names in the semantically close array condition (Q = 12.24, p < .01, df = 3). Reference to Figure 2A reveals that this difference corresponded to an increase in the error rate following initially accurate performance on the first probe. No such between-probe difference was observed when the same food names were probed under distant array conditions (Q = 3.00, p > .3, df= 3). By contrast, in the drink and non-edible solid experiments, significant differences between the number of errors committed on each probe were observed both with semantically close arrays (Q =8.23, p < .05, df = 3 and Q = 12.00, p < .01, df =3, respectively) and with semantically distant arrays (Q = 13.15, p < .01, df = 3 and Q = 10.86, p < .02, df = 3, respectively). In all cases, these differences reflected a gradual increase in error rate from initially accurate performance on the first probe to more inaccurate performance on subsequent probes.

Comment

The observation of a semantic distance effect in A.Z.'s identification of food names provides empirical support for the role of semantic similarity in the fine-grain organisation of mass nouns. However, the absence of equivalent effects in the categories of drinks and non-edible solids despite overall error rates which are comparable to that observed in the foods experiment suggests that, for this individual patient, the level of organisation is not identical in every semantic domain. More specifically, greater personal knowledge of domain as compared with another may have motivated differential patterns of semantic organisation. Thus the ability of the semantic distance paradigm to demonstrate fine-grain category specific effects may be limited to areas of semantic cognition in similarity which is particularly strongly represented. To some extent, the strength of this representation will be individually determined, depending on the depth of an individual's knowledge base.

Experiment 4 Effect of Shared Mass/Noun Status upon Refractoriness Effects

It has been demonstrated previously that at least a major component of the refractory access deficit



Fig. 2 – The percentage correct responses (histogram) and number of errors on successive probes (line graph) are shown for semantically close and distant arrays of (A) food mass nouns, (B) drink mass nouns, and (C) non-edible solid nouns (Experiment 3).

exhibited by A.Z. lies at the level of conceptual processing (Experiment 1 and Crutch and Warrington, 2004). The current observations of semantic distance effects add further weight to this position. It is in this context that A.Z. offers the opportunity to examine whether the distinction

between mass nouns and count nouns is represented at the conceptual level, syntactic level or partly at both stages of processing. More specifically, we examine among semantically similar items, is refractoriness enhanced if mass/count noun status is shared?

Procedure

The stimuli consisted of 8 count nouns and 8 mass nouns. These items were arranged into stimulus pairs under three conditions (see Appendix VI):

(i) Semantically close arrays – Same noun type: this condition yielded four 4 two-item arrays containing two conceptually similar count nouns (e.g., cloud, storm) and 4 arrays containing two conceptually similar mass nouns (e.g., rain, snow).

(ii) Semantically close arrays – Different noun type: 8 arrays containing two items which are conceptually similar but which differ in their mass/count status (e.g., cloud, snow).

(iii) Semantically distant arrays – Mixed noun type: 8 arrays containing two semantically dissimilar items. Half the arrays contained items with the same mass/count status (e.g., snow, pork) and half items with a different status (e.g., branch, thunder).

The task was administered using a spoken word-written word matching paradigm. For every pair of items, the identity of each word was probed five times in a pseudo random order (i.e., a total of 10 responses per item pair). In order to ensure that the subject did not use the simplicity of the twoitem written word array to associate a particular response simply with pointing to the left or right, the word array was altered throughout the experiment so that for half of the responses a particular written word appeared on the left whilst on the remaining half of responses the same word appeared on the right. The location of the target was designed such that the correct response was to point to the left equally as often as to the right. A 1 sec RSI was used, and arrays from the three conditions were administered in a counterbalanced design, ensuring that no stimulus item appeared in consecutive arrays.

Results

The percentage correct responses under the three experimental conditions are shown in Figure 3A. A series of pairwise Wilcoxon matched-pairs signed-ranks tests revealed that A.Z. made significantly more errors on both the semantically close/same noun type and semantically close/different noun type arrays than on the semantically distant arrays (z = 2.08, p < .05 and z= 2.40, p < .02, respectively). However, looking at the two types of semantically close arrays, there was no difference in response accuracy whether or not the stimuli were drawn from the same or different class of nouns (z = .29, p > .7). The serial position curves describing the percentage error rates for each probe of the test stimuli are shown in Figure 3B. As with Experiments 2 and 3, A.Z.'s performance is generally characterised by a deterioration in accuracy with repeated probing of an item's identity. It is of note that in this case, serial position effects are observed with both the

semantically close arrays and semantically distant arrays; we would attribute the latter effect to the fact that in a two-item array, the same stimuli are probed five times in rapid succession.

Comment

A.Z.'s accuracy in identifying both mass and count nouns appears to be significantly affected by the semantic similarity of the target item to the distractor item. However, the degree of mass/count status similarity between target and distractor seems to have no effect upon the probability of an accurate response. In A.Z. the refractoriness observed between semantically similar items does not appear to be enhanced by shared mass/count noun status.

DISCUSSION

In this paper, we report a series of experiments conducted with a patient with semantic refractory access dysphasia which provide information about fine-grain organisation of conceptual the knowledge relating to mass nouns and parts of speech. In particular, it has been shown that there is no gradient of semantic relatedness across different parts of speech whereas there is a gradient of semantic relatedness across the broad mass noun domain. This gradient is considered to reflect the build up of refractoriness leading to a higher error rate when identifying targets under conditions of semantically similar than semantically dissimilar distractor items. Moreover, a more fine-grain level of organisation has been detected within some mass noun categories (e.g., foods) but not others (e.g., drinks and non-edible solids). Finally, identification of written mass and count noun terms was also found to be affected by semantic similarity between the target and distractor but not by whether the target and distractor were drawn from the same noun class. These results are discussed in terms of potential principles of semantic organisation within the mass noun domain, and also with reference to existing theoretical models of the mass/count distinction.

Although several neuropsychological reports in the literature detail patients who show a selective deficit for either mass or count nouns, these impairments correspond to an inability to use specific grammatical rules corresponding to a particular class of noun rather than a selective inability to comprehend a class of words per se (e.g., Semenza et al., 1997). The current study does not counteract this trend; we do not provide evidence of a dissociation between mass and count nouns at the level of comprehension. However, to the best of our knowledge, we do provide the first empirical evidence of a fine-grain level of organisation between such concepts. These results extend our previous observations of gradients of semantic



Fig. 3 – Performance on the noun class and semantic similarity task (Experiment 4). (A) The percentage correct scores for the semantically close (same noun type), close (different noun type) and distant arrays. (B) The number of errors made on consecutive probes of the test stimuli under the three experimental conditions.

relatedness in the count noun domain (Crutch and Warrington, 2005). With regard to the absence of a semantic distance effect with drinks and non-edible solids, it should be noted that premorbid personal knowledge may affect significantly the quality and quantity of organisation within the conceptual system. Thus we would predict contrasting semantic distance patterns to those observed in the current patient if an equivalent refractory access deficit were to be present in an individual with an extensive understanding of the drinks or textiles market. A similar account was given for the observation that A.Z., an English lady, showed semantic distance effects in her identification of the names of English towns and cities but not US states (Crutch and Warrington, 2003).

It has been hypothesised that neurological deficits with a refractory access quality may affect any cognitive system (McCarthy and Kartsounis, 2000; Crutch and Warrington, 2001). With the present patient A.Z., it had been demonstrated previously that identification of stimuli was affected significantly more by the semantic relatedness of stimuli than by their phonological relatedness (Warrington and Crutch, 2004). This result was held to indicate that a significant proportion of A.Z.'s

refractory deficit could not be attributed to presemantic aspects of information processing. In Experiment 1 of this study, this information processing analysis was extended by testing for evidence of a post-conceptual locus for the refractory disorder. This was achieved by examining the influence of syntactic similarity (stimulus items drawn from the same parts of speech category or different parts of speech categories) upon the build up of refractoriness in a written word identification paradigm. No effect of syntactic similarity was observed. We consider the result of Experiment 1 to indicate that syntactic information is not strongly represented at the information processing stage which is primarily affected by refractoriness. As this result constitutes a negative finding, its interpretative power is relatively weak; however, we would claim that the failure to find a syntactic similarity effect suggests that the refractory disorder in A.Z. is localised to a conceptual level of processing. In other words, Experiment 1 fails to provide any clear evidence that refractoriness affects the level at which syntactic information is represented (either syntactic or lemma level representations, depending upon whether one adheres to the single or multiple stages of semantic processing viewpoint).

Having provided empiricial evidence which is at least highly consistent with a refractory disorder which is restricted largely to pure conceptual processing, we attempted to examine directly mass/count status information whether is represented at the conceptual level of processing. The rationale for this hypothesis was that shared mass/count status (above and beyond semantic similarity) might yield some enhancement of the refractory effect in our patient. The findings of Experiment 4 are essentially negative, particularly bearing in mind that the refractory effects were generated in each condition using small stimulus sets. As such this null result cannot contribute very much to the debate as to whether the distinction between mass and count nouns is fundamentally semantic or syntactic in nature (e.g., Jackendoff, 1991; Vigliocco et al., 1999).

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References

- BORGO F and SHALLICE T. When living things and other "sensoryquality" categories behave in the same fashion: A novel category-specificity effect. *Neurocase*, 7: 201-220, 2001.
- BORGO F and SHALLICE T. Category specificity and feature knowledge: Evidence from new sensory-quality categories. *Cognitive Neuropsychology*, 20: 327-353, 2003.
- BUNT HC. The formal semantics of mass terms. In Kailsson F

(Ed), Papers from the Third Scandinavian Conference of Linguistics. Turku: Academy of Finland, 1976.

- CAPITANI E, LAIACONA M, MAHON B and CARAMAZZA A. What are the facts of semantic category-specific deficits? A critical review of the clinical evidence. *Cognitive Neuropsychology*, 20: 213-261, 2003.
- CARAMAZZA A. How many levels of processing are there in lexical access? Cognitive Neuropsychology, 14: 177-208, 1997.
- CIPOLOTTI L. Sparing of country and nationality names in a case of modality-specific oral output impairment: Implications for theories of speech production. *Cognitive Neuropsychology*, *17*: 709-729, 2000.
- CRUTCH SJ and WARRINGTON EK. Refractory dyslexia: Evidence of multiple task-specific phonological output stores. *Brain*, *124:* 1533-1543, 2001.
- CRUTCH SJ and WARRINGTON EK. Spatial coding of semantic information: Knowledge of country and city names depends upon their geographical proximity. *Brain*, *126*: 1821-1829, 2003.
- CRUTCH SJ and WARRINGTON EK. The semantic organisation of proper nouns: The case of people and brand names. *Neuropsychologia*, 42: 584-596, 2004.
- CRUTCH SJ and WARRINGTON EK. Gradients of semantic relatedness and their contrasting explanations in refractory access and storage semantic impairments. *Cognitive Neuropsychology*, 22: 851-876, 2005.
- GILLON B. Towards a common semantics for English count and mass nouns. *Linguistics and Philosophy*, 15: 597-640, 1992.
- JACKENDOFF R. Parts and boundaries. In Levin B and Pinker S (Eds), Lexical and Conceptual Semantics. Oxford: Blackwell, 1991.
- KAY J, LESSER R and COLTHEART M. PALPA: Psycholinguistic Assessments of Language Processing in Aphasia. Hove: Lawrence Erlbaum Associates, 1992.
- MCCARTHY RA and KARTSOUNIS LD. Wobbly words: Refractory anomia with preserved semantics. *Neurocase*, 6: 487-497, 2000.
- MONDINI S, JAREMA G and LIGUORI F. Semantics and syntax of mass and count nouns: Data from aphasia and dementia. *Brain and Language*, *91*: 138-139, 2004.
- PATTERSON K and HODGES JR. Deterioration of word meaning: Implications for reading. *Neuropsychologia*, 30: 1025-1040, 1992.
- SEMENZA C, MONDINI S and CAPPELLETTI M. The grammatical properties of mass nouns: An aphasia case study. *Neuropsychologia*, 35: 669-675, 1997.
- SEMENZA Č, MONDINI S and MARINELLI K. Count and mass nouns: Semantics and syntax in aphasia and Alzheimer's disease. *Brain and Language, 74:* 428-431, 2000.
- SOJA NN. Inferences about the meanings of nouns: The relationship between perception and syntax. *Cognitive Development*, 7: 29-45, 1992.
- SOJA NN, CAREY S and SPELKE ES. Ontological categories guide young children's inductions of word meaning: Object terms and substance terms. *Cognition*, 38: 179-211, 1991.
- TALER V, JAREMA G and ŠAUMIER D. Processing mass/count information in semantic dementia and agrammatic aphasia. *Brain and Language*, 91: 160-161, 2004.
 VIGLIOCCO G, VINSON DP, MARTIN RC and GARRETT M. Is "count"
- VIGLIOCCO G, VINSON DP, MARTIN RC and GARRETT M. Is "count" and "mass" information available when the noun is not? An investigation of tip of the tongue states and anomia. *Journal of Memory and Language*, 40: 534-558, 1999.
- WARRINGTON EK and CRUTCH SJ. A circumscribed refractory access disorder: A verbal semantic impairment sparing visual semantics. Cognitive Neuropsychology, 21: 299-315, 2004.
- WARRINGTON EK and MCCARTHY R. Čategory specific access dysphasia. Brain, 106: 859-878, 1983.
- WARRINGTON EK and MCCARTHY R. Categories of knowledge: Further fractionations and an attempted integration. *Brain*, *110*: 1273-1296, 1987.
- WISNIEWSKI EJ, IMAI M and CASEY L. On the equivalence of superordinate concepts. *Cognition*, 60: 269-298, 1996.

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APPENDIX I

The stimulus arrays for the same and different parts of speech conditions (Experiment 1)

Parts of speech arrays								
Same parts	Same parts of speech							
	Nouns	А	djectives		Verbs	ŀ	Adverbs	
emission calculus stipend bard	tendency virtue mood devotion	pliable arid frugal grisly	foolish usual humble social	kindle simper usurp abhor	seem harm guess been	divinely slyly mortally wantonly	simply quickly softly easily	
Different pa	erts of speech							
bard kindle pliable divinely	tendency guess usual simply	simper frugal slyly calculus	been foolish quickly mood	arid mortally stipend usurp	humble easily virtue seem	wantonly emission abhor grisly	softly devotion harm social	

APPENDIX II

The semantically close, medium and distant arrays used in Experiment 2

Variable distance arrays Close arrays								
						Solids	Liquids	Gases
etin copper zinc	petrol oil acid	oxygen helium air	lamb beef pork	rice pasta bread	wine beer sherry	ruby emerald diamond	silver bronze gold	marble granite quartz
Middle ar	rays							
Chemicals			Consumal	bles		Precious m	inerals/metals	7
tin oil air	petrol helium Zinc	oxygen copper acid	lamb pasta sherry	rice beer pork	wine beef bread	ruby bronze quartz	silver granite diamond	marble emerald gold
Distant ar	rays							
tin pasta quartz	petrol beer diamond	oxygen beef gold	lamb bronze air	rice granite zinc	wine emerald acid	ruby oil sherry	silver helium pork	marble copper bread

APPENDIX III

The semantically close and distant arrays of food items used in Experiment 3

Food mass noun arrays Close arrays				
beef lamb pork veal	cheddar brie stilton edam	trifle custard pavlova semolina	ketchup mustard vinegar mayonnaise	
Distant arrays				
veal cheddar pavlova ketchup	mustard brie trifle lamb	pork stilton custard vinegar	edam mayonnaise semolina beef	

APPENDIX IV

The semantically close and distant arrays of drink items used in Experiment 3

Drink mass noun arrays						
Close arrays	Close arrays					
Long drinks	Spirits	Hot drinks	Mixers			
lager	rum	coffee	water			
beer	brandy	tea	lemonade			
cider	vodka	ovaltine	soda			
shandy	whisky	cocoa	tonic			
Distant arrays						
coffee	lager	rum	cider			
vodka	lemonade	shandy	whisky			
beer	tea	water	cocoa			
soda	brandy	ovaltine	tonic			

APPENDIX V

The semantically close and distant arrays of non-edible solid items used in Experiment 3

Non-edible solid mass noun arrays						
Close arrays	Close arrays					
Metals	Stones	Heavy fabrics	Light fabrics			
iron copper steel lead	marble granite concrete slate	corduroy tweed denim flannel	linen silk nylon cotton			
Distant arrays						
iron corduroy marble linen	nylon denim concrete steel	granite tweed copper silk	flannel lead slate cotton			

APPENDIX VI

The semantically close same noun type arrays, semantically close different noun type arrays and semantically distant noun arrays used in Experiment 4

Mass vs. count noun arrays				
Semantically close pairs		Semantically distant pairs		
Same noun type	Different noun type			
cloud – storm ¹ branch – twig ¹ blizzard – hurricane ¹ steak – chop ¹ snow – rain ² wood – bark ² thunder – lightning ² pork – mince ²	snow – cloud rain – storm branch – bark twig – wood pork – steak mince – chop blizzard – lightning hurricane – thunder	snow – pork rain – mince steak – cloud storm – chop branch – thunder twig – hurricane lightning – bark wood – blizzard		

¹Same noun type pairs consisting of two count nouns. ²Same noun type pairs consisting of two mass nouns.