

Original Article

Human vocabulary use as display

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Abstract: The average human vocabulary consists of approximately 20,000 word families, yet only 6000-7000 word families are required to understand most communication. One possible explanation for this level of redundancy is that vocabulary size is selected as a fitness indicator and is used for display. Human vocabulary size correlates highly with measurable intelligence and when choosing potential mates individuals actively prefer other correlates of intelligence, such as education. Here we show that males used more low frequency words after an imaginary romantic encounter with a young female shown in a photograph relative to when they viewed photographs of older females. Females used fewer low frequency words when they imagined a romantic encounter with a young male shown in a photograph relative to when they viewed photographs of older males. These differences in male and female vocabulary displays may be related to sex differences in investment costs in offspring.

Keywords: vocabulary, sexual selection.

Introduction

There are many hypotheses on the evolution of language (e.g. Dunbar, 1993; Hauser, Chomsky, and Fitch, 2002; Lieberman, 2006; Locke and Bogin, 2006; Pinker and Bloom, 1990). However, few of these hypotheses are able to explain why humans have such vast vocabularies. It is not atypical for an adult English speaker to know 100,000 words (Pinker, 2003), but only a few thousand are required for conversation or even to appreciate literature (Nation, 2006). This is a surprising discrepancy since natural selection does not usually favor waste (Ridley, 2004). Darwin proposed that the origin of language was in courtship calls (Darwin, 1871/2004). Yet other primates manage rich social interaction with remarkably few distinct calls (Cheney and Seyfarth, 1998). A possible explanation of this apparent redundancy was proposed by Miller (2000) who suggested that individuals use vocabulary to demonstrate their intelligence, and consequently their

“fitness” to potential mates. Here we explore the possibility that vocabulary is a proxy for intelligence and is subject to sexual selection. If so, vocabulary is likely to be used as a sexual display. We present an experimental test of this hypothesis.

A surfeit of words?

Conservative estimates suggest that a well-educated, native English speaker knows about 20,000 word families (Goulden, Nation, and Read, 1990; Zechmeister, Chronis, Cull, D’Anna, and Healy, 1995). A lexicon of this size does not seem necessary considering that in 1935 Longman compiled a “defining vocabulary” of 2,000 of the most common words from which all definitions in their dictionaries are now written (Bullon, 2007). Word frequency in any language is described by Zipf’s law (Zipf, 1932). This states that the frequency of any word is inversely proportional to its rank in the frequency table of the corpus to which it belongs. For instance, of the 757,087 different word forms in the in the British National Corpus (Davies, 2008) 397,041 of them are *hapax legomenon*, words which appear just once, and there are only 124,002 word forms that occur in the British National Corpus more than ten times. The word “the” alone typically accounts for over 6% of all words (Leech, Rayson, and Wilson, 2001). Since conversation and text are dominated by relatively few different words it would be expected that the majority of spoken and written language could be understood with only a limited vocabulary.

Nation (2006) examined what size vocabulary is needed to understand written text and speech before unknown words interfere with comprehension. Knowledge of 98% of words in a given text or conversation has long been used by linguists as a level at which adequate comprehension is achieved (e.g. Francis and Kucera, 1979). Nation (2006) found that 4,000 and 9,000 word families were sufficient for the comprehension of 95% and 98% of the text respectively, within classic books by authors including Henry James, F. Scott Fitzgerald, D.H. Lawrence and H.G. Wells. Nation (2006) also found that even fewer words were necessary for the comprehension of unscripted conversations. Knowledge of 3,000 word families gave coverage of over 95% of dialogues, and knowledge of 6,000-7,000 is words needed for 98% coverage (Nation, 2006). Thus, vocabulary size does appear to be larger than is necessary for producing and comprehending most linguistic communication.

Indicators of fitness

Sexual displays that indicate an individual’s “fitness” have been documented throughout the animal kingdom (Andersson, 1994). This includes traits that even appear to harm an individual’s survival ability (Zahavi, 1975). Due to the differing contribution of resources to offspring by males and females it is expected that the sex that contributes the least is the one that usually produces the most vigorous sexual displays (Trivers, 1972).

In humans, it has been proposed that creativity (Griskevicius, Cialdini, and Kenrick, 2006; Kanazawa, 2000) and intelligence can indicate “mental fitness” (Miller, 2000). A recent study measured general intelligence using five different tests (including the Ravens Advanced Progressive Matrices and the Weschler Adult Intelligence Scale) and found a significant correlation between intelligence and body symmetry (Prokosch, Yeo, and Miller, 2005). Other studies have also reported positive correlations between measures of intelligence and symmetry (e.g. Bates, 2007; Furlow, Armijo-Prewitt, Gangestad, and Thornhill, 1997). This suggests that intelligence could be a reliable indicator of

developmental stability and heritable fitness. One of the most convincing findings from the psychological literature is that intelligence is highly heritable and that it has the highest heritability of any adult trait (Bouchard, Lykken, McGue, Segal, and Tellegen, 1990; Carroll, 1993). Moreover, there is evidence to suggest that intelligence is a much sought after trait in potential partners (Buss et al., 1990).

Selection of intelligence

Studies of human mate preferences reveal how certain psychological traits appear to be subject to selection pressures. Across 37 different cultures intelligence, kindness and understanding are rated the most important characteristics in a partner, by both sexes (Buss et al., 1990). Pawlowski and Koziel (2002) obtained evidence from real mating situations with actual consequences by analyzing 2008 personal advertisements for traits that successfully attracted responses by potential partners. They found that for men the best predictor of number of responses was their level of education, which is strongly associated with intelligence (Kaufman and Wang, 1992), those with higher education received more responses. However, for females the reverse was found. It was unusual for males to prefer female partners with significantly higher levels of education than themselves (Pawlowski and Koziel, 2002). Analyses of speed dating events reveal similar preferences in the selection of romantic partners (Fisman, Iyengar, Kamenica, and Simonson, 2006). These studies all suggest that intelligence is actively selected and that education level can be one indicator of this. Although formal education will not have been selected in the past, as it is a recent phenomenon, vocabulary is a direct indicator of intelligence that would have been readily perceivable by potential mates in the past.

Vocabulary as an indicator of intelligence

For vocabulary to be a valid and reliable indicator of intelligence it would be expected to be heritable and for there to be a strong correlation between vocabulary knowledge and performance on intelligence tests. Tests of verbal ability are components of intelligence tests themselves; the SAT (scholastic aptitude test) and Weschler Adult Intelligence Scale both rely on verbal elements, including vocabulary tests. In the standardization sample of the Weschler Adult Intelligence Scale the vocabulary subtest correlates .75 with the full scale score, which is higher than the other subtests (Wechsler, 1958). Since vocabulary is part of the definition of intelligence (at least traditional measures of it) it is not surprising that it is heritable. A study of 71 monozygotic and 78 dizygotic twins reported heritability of vocabulary at .74 and .41 respectively (Bratko, 1996). In a longitudinal genetics study of 997 adults, all twins or siblings of twins, van den Berg, Posthuma and Boomsma (2004) reported that around 76% of vocabulary knowledge over time can be explained by genetic factors. Furthermore, Stromswold (2001) reviewed more than a hundred genetic studies and concluded that the variance of linguistic ability is influenced by genetic factors.

Of course both intelligence and vocabulary are observable characteristics that are influenced by many factors including heritability. However, it is observable characteristics that are subject to sexual selection on the basis that they reflect not just heritable factors but also environmental (including social) factors. For instance, differences in vocabulary that result from dialects are not likely to have a genetic component, but may nonetheless be subject to selection pressures (Dunbar, 1996).

Sex differences in language usage?

Although there may not be large sex differences in linguistic ability (Hyde and Linn, 1988) or total output (Mehl, Vazire, Ramírez-Esparza, Slatcher, and Pennebaker, 2007) there is research suggesting that males and females may use communication differently. Studies of conversation in natural social settings reveal that males devote more time to topics of self-promotion compared to females, and that this bias is exaggerated when females are present (Dunbar, Marriott, and Duncan, 1997). This behavior has characteristics in common with the male sexual display of a mating lek (Rowe and Houle, 1996). Kanazawa's (2000) analysis of cultural displays also points to a strong male bias in cultural output. This is reminiscent of the literature on animal signaling, where most of the signals that animals produce are intended to influence the behavior of others (Krebs and Dawkins, 1984). In humans a meta-analytic review of sex variation in language use during speech showed that numerous factors (e.g. whether the group was same or mixed sex, the familiarity of the setting, whether the conversation was with a stranger or a close relation), moderated levels of talkativeness and whether speech was classified as "assertive" or "affiliative" (Leaper and Ayres, 2007). In fact males tended to dominate women in conversation through high levels of talkativeness.

Priming mating motivation

It has been argued that mental mechanisms have evolved to solve adaptive problems and that these mechanisms can be particularly sensitive to ecological cues suggesting either an opportunity or a threat (Cosmides and Tooby, 1992; Öhman and Mineka, 2001), even without explicit awareness (Bargh and Chartrand, 1999). Individuals primed with cues related to mating produced higher levels of creativity on a writing task compared to those primed with non-mating cues (Griskevicius et al., 2006). Roney (2003) found that mating cues changed males' attitudes towards a greater conformity with the attitudes preferred by females. Furthermore, Wilson and Daly (2004) reported, also using a mate priming paradigm, that males significantly increased discounting of the future in a monetary choice task after viewing photographs of attractive females compared to unattractive females. Discounting is a standard measure of impulsivity and risk seeking behavior. To our knowledge there are no studies exploring the effect of a mating prime on an individual's use of vocabulary.

The present study tested the hypothesis that vocabulary is used as a sexual display by presenting mating primes in the form of photographs of young members of the opposite sex and asking participants to imagine a romantic scenario with them. We hypothesized that participants would use more low frequency words following such a prime relative to a control condition where the prime was a photograph of older members of the opposite sex and an imaginary non-romantic encounter. Differences in vocabulary output were measured using written autobiographical descriptions. Vocabulary is convenient to measure quantitatively because words can be ranked objectively by frequency and output can be measured for the number of different lower frequency words used (word range). Theory and data from parental investment models, research on sexual displays, social interaction and previous work with mate priming paradigms led us to predict that participants would show a greater use of lower frequency words in the mating prime condition compared to the non-mating prime condition.

Materials and Methods

Design

We used a 2x2 factorial design with Sex (male versus female) and Prime (young versus old) as between subjects factors – half the participants were primed by photographs of young members of the opposite sex and half were exposed to photographs of older members of the opposite sex. All of the participants then wrote a short autobiographical statement that provided the dependent variable of word frequency (this is explained in more detail in the results).

Participants

Eighty-eight unpaid participants from undergraduate psychology classes at the University of Nottingham volunteered for the study. Three were excluded because they failed to complete the test phase. Of the remaining 85 participants 33 were male and 52 were female. Mean age for males was 21.1 years ($SD = 3.3$) and the mean age for females was 19.3 years ($SD = 1.6$).

Materials

Photographs were collected from publicly available websites of fashion model agencies. Their presence on fashion model websites was taken to indicate that the models were of above average attractiveness and likely to be desirable to participants. Arrays of 4 photographs were used in each condition for each sex, giving a total of 16 photographs. Photographs were headshots and the dimensions were 365 x 530 pixels. The mean age of the male older models was 57.3 years ($SD = 4.5$) and the mean age of the older female models was 55.8 years ($SD = 4.3$). It was assumed that the undergraduate participants in this experiment would not consider the older models as potential partners (c.f. Buss, 1989). The mean age of the younger male models was 22.8 years ($SD = 2.5$) and the mean age of the younger female models was 21.8 years ($SD = 2.2$). It was assumed that the participants would consider at least one of the four models shown in the arrays of younger models as a potential partner.

Procedure

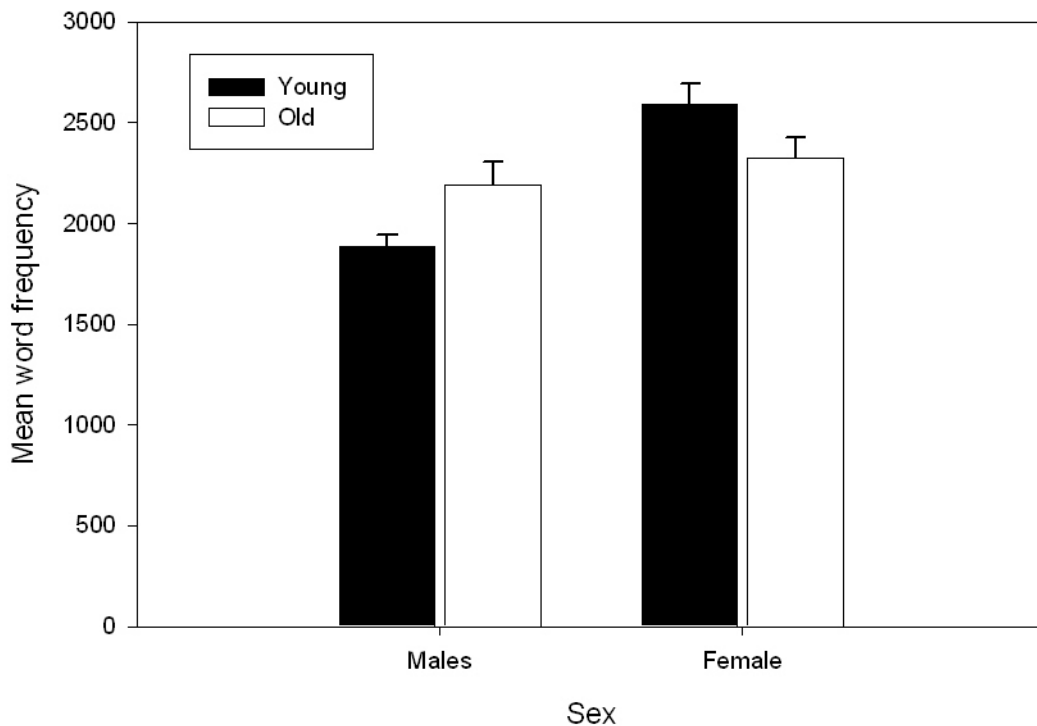
The participants were randomly assigned to one of the two prime conditions. Participants who saw photographs of younger models were then instructed to select one of the four photographs they thought would be the most desirable romantic partner (priming phase). The selected image remained on the monitor and the others disappeared. The participants were then given three minutes in which they were asked to imagine a romantic encounter with the person shown in the image that they selected. During this period they were asked to give a written description of such an encounter. Due to the likely personal nature of the written descriptions the participants were assured that the process was anonymous and confidential. The participants who saw photographs of older models underwent an identical procedure except they were told to select the person who they thought would be the most pleasant to chat to in a chance meeting and then to write about what this meeting might be like. Since written descriptions of the different kinds of encounters might require words with different frequencies we did not analyze these data. Instead, once this description was complete a second text box appeared next to the selected

image and participants in both conditions were given identical instructions to write about their first experiences at university. It was suggested that it could include descriptions of student life and whether the participant was enjoying it and what their ambitions for the future were. This was a subject common to all of the participants in this sample and afforded an opportunity for articulation. The image and instructions remained on the screen for ten minutes. The participants were again assured that the information provided was anonymous and confidential. They were also asked to avoid using instant messenger chat or mobile phone text style spelling.

Results

Variation in frequencies of the 2,000 most frequent words in the British National Corpus has been estimated at no more than 3% (Nation, 2006). The present study investigated possible variation in the least frequent words, so before the data was analyzed the 100 most frequent words in the British National Corpus were excluded (reducing the text by 44%), the analyses were then carried out on those words occurring in the first quartile of frequency. Word frequency represents the number of occurrences of the word in the British National Corpus. Raw word lists in all conditions were corrected for spelling. Thus the dependent variable is the mean frequency in each autobiographical statement. The resulting data are shown in Figure 1 and were entered into a 2 (sex: male versus female) X 2 (Prime: younger versus older) between subjects analysis of variance. There was no main effect of Prime ($F(1,81) = .033$, $MSE = 7095.866$, $p = .857$). Overall participants who saw younger models did not show lower word frequency scores ($M = 2313.9$, $SD = 556.4$) than those who saw older models ($M = 2274.3$, $SD = 490.3$). There was, however, a significant main effect of Sex ($F(1,81) = 16.225$, $MSE = 3,520,068.066$, $p < .001$), indicating that female word frequency scores ($M = 2458.3$, $SD = 537.1$) were significantly higher than male word frequency scores ($M = 2035.9$, $SD = 378.4$). There was also a significant interaction between Prime and Sex ($F(1,81) = 7.713$, $MSE = 1,673,455.167$, $p = .007$). For males, priming with photographs of younger females and an imagined romantic encounter led to lower mean frequency scores than when they were primed with older females and a non-romantic encounter ($t(31) = 2.513$, $p = .017$). By contrast, females primed with photographs of young male models and an imagined romantic encounter tended to use higher frequency scores than when primed by older male models and an imaginary non-romantic encounter ($t(50) = 1.850$, $p = .06$).

Figure 1. Word frequencies by condition. Bars show means and SEMs.



Discussion

To our knowledge, the present experiment is the first to investigate the effects of a mating prime on vocabulary usage. The hypothesis was that individuals who were primed with mating cues would use a greater number of lower frequency words compared to those primed with cues unrelated to mating. This study was intended to extend previous work where similar paradigms have been used to test the effects that mate priming has on discounting the future (Wilson and Daly, 2004), attitudes (Roney, 2003) and motivation for displays of creativity (Griskevicius et al., 2006). The data from the current study showed that, as predicted, priming by photographs of young female models and an imagined romantic encounter led male participants to use a greater number of lower frequency words. That is, imagining spending time with a desirable partner led to a display of linguistic ability from which they could not benefit in the current setting. For females, being primed by young male models and an imaginary romantic encounter led to a greater use of higher frequency words. This effect is in the opposite direction to that predicted but should be treated with some caution since it is only marginally significant ($p = .06$).

These findings are consistent with theories of sexual selection, where males, who have a lower minimum cost of parental investment, produce displays to attract females, and that these displays would be expected to be more pronounced than displays made by females to attract males (Andersson, 1994; Griskevicius et al., 2006; Kanazawa, 2000; Trivers, 1972). The findings also provide further evidence that males are sensitive to

environmental cues that are biologically salient (Cosmides and Tooby, 1992; Öhman and Mineka, 2001). The results are also compatible with work showing that human males exaggerate traits that are known to be sought by females in a romantic partner (Dunbar et al., 1997). The data also provides support for the hypothesis that vocabulary is used by males to display their intelligence and fitness (Miller, 2000; Prokosch et al., 2005). An alternative explanation is that the younger female images did not lead to an increase in use of lower frequency words but that there was a decrease in use of lower frequency words following exposure to the older female images. However, we know of no research, or likely hypothesis, that would explain why males might alter their behavior in this way in the context of an older female. For females, being primed by an imaginary romantic encounter with young males led to a greater use of higher frequency words, in the opposite direction to that of males, however the difference was marginal.

Why would the pattern be different for males and females? Previously it has been shown that females did not respond to a mating prime when asked to produce a display of creativity (Griskevicius et al., 2006). This could be due to females being less aroused by visual images than men are (Hamann, Herman, Nolan, and Wallen, 2004), but it could also be that females do not expend greater effort on a sexual display unless a potential mate is considered a long-term prospect (Li, 2007). The present study did not specify whether the romantic scenario should be considered a short or long-term encounter, but the differences between these types of relationship have obvious implications, especially for a female with the risk of parenthood. Griskevicius *et al's* (2006) work suggested that the paradigm used here was interpreted by participants as a short rather than a long-term scenario and that females' threshold for producing sexual displays of creativity are significantly higher than are males. As the data in the present study did not reach the criterion for statistical significance a cautious interpretation would be judicious. It is possible that female use of vocabulary is not affected by priming in this way. However, it could be asked why females might use a greater number of higher frequency words in a mating scenario. It is possible that a female strategy is to not risk being viewed as more intelligent than a prospective male partner. Although data is scarce on how humans actually behave in mating situations this finding would be consistent with some previous research. Both sexes have stated preferences for intelligent long-term partners (Buss et al., 1990) but there is data to suggest that males do not want a partner who is more intelligent than they are. Fisman *et al's* (2006) study of speed dating events found that males did not seek a female who was more intelligent than themselves. Pawlowski and Koziel (2002) reached a similar conclusion to that of Fisman *et al* (2006). It is then plausible that females are aware of these male preferences and adjust their behavior to avoid the risk of appearing more intelligent than a potential male partner and potentially impairing their perceived attractiveness. An alternative explanation for a contrasting result for females compared to males is that females responded to the older males in the non-mating condition as a potential mate rather than the younger males in the mating condition. This seems unlikely for two reasons – first, although it has been claimed that females prefer older males this stated preference is for males to be older on average by 3.42 years (Buss, 1989). However, in the present study the older males were some 38 years older. Second, females who saw images of young males were instructed to think about their chosen male in a romantic scenario whereas there was no mention of a romantic scenario for those who saw images of older males.

Although the present study did not specify whether participants should consider the

person in the romantic scenario as a short or long-term prospect, it would be expected that males and females would approach each of these scenarios with different behavioral strategies (Li, 2007; Trivers, 1972). It has previously been shown that the threshold for females to display linguistic ability is higher than for males (Griskevicius et al., 2006). This might explain why in the present study the mating prime failed to lead to a change in female vocabulary use. Although the age of the participants in the present study was well suited to a study of mating preferences, most participants from this demographic would not be expected to be either parents or married (Buss et al., 1990). It remains to be seen how these findings would generalize to different populations and contexts.

Future research might determine if vocabulary used in this way is universal by testing participants with different cultural backgrounds. Indeed there are clear cultural differences as well as commonalities in factors affecting mate choice (Buss et al., 1990). It is plausible that undergraduates are more likely to utilize vocabulary as a form of display than people from other socio-economic groups. The relative weight placed on different aspects of mate choice may differ from one-context to another, and from one group to another. Moreover, because we did not have a same-sex comparison we are unable to rule out the possibility that the males in our study might have used low frequency words in order to impress in a non-mating situation.

There also remains the question of whether vocabulary can be used to deceive potential mates into believing that the male is a better prospect than they actually are. It is tempting to speculate that undergraduates (and other academics) might attempt to inflate other people's estimates of their intelligence by deliberately using low frequency words in the presence of people that they wish to impress. The fact that we observed differences in word frequencies between conditions seems to make this explanation unlikely. It is our belief that the effect was unintentional on the part of the participants because although they were aware that the text that they wrote would be analyzed, they did not know that it would be analyzed for word frequency. Moreover, if males do attempt to manipulate potential mates' estimates of their fitness by deception we should expect females to have evolved some mechanism to detect deceptive displays (c.f. Cosmides and Tooby, 1992). While such a deception might be effective for a short-term encounter it is unlikely to be convincing in the long-term. Certainly future research will need to test whether females actually select males who use low frequency words, and we may then ask if this is relevant to short- or long-term unions.

The current work tested males and females in a laboratory environment with a fictional social scenario; future work might seek to replicate this study in an actual verbal courtship situation. It would be expected that the presence of an attractive mate would lead to an even more powerful display of linguistic ability, at least for males. If individuals do use vocabulary in a mating scenario a natural extension of this work would be a test to see if this usage of lower frequency words is actively selected. Would individuals who use a greater number of lower frequency words be preferred over those using fewer lower frequency words? If this were shown it would also be interesting to find out whether there would be an optimum number of lower frequency words mediating perceived attractiveness.

In conclusion, the results indicated that when males merely imagined being with a romantic partner use of lower frequency words was higher compared to imagining being with a non-romantic partner, thus providing some preliminary evidence in support of the

hypothesis that males use vocabulary to display intelligence in this context (Miller, 2000). It is also consistent with the literature which suggests that although the majority of lower frequency words are not necessary for comprehending most communication (Nation, 2006) they do become more salient following priming with a mating scenario when displaying intelligence would be preferred, at least by females (Buss et al., 1990).

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