Psychological Research
DOI 10.1007/s00426-011-0374-z

ORIGINAL ARTICLE

Phonotactic probability of brand names: I'd buy that!

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Received: 29 March 2011 / Accepted: 12 August 2011

Abstract Psycholinguistic research shows that word-characteristics influence the speed and accuracy of various language-related processes. Analogous characteristics of brand names influence the retrieval of product information and the perception of risks associated with that product. In the present experiment we examined how phonotactic probability—the frequency with which phonological segments and sequences of segments appear in a word—might influence consumer behavior. Participants rated brand names that varied in phonotactic probability on the likelihood that they would buy the product. Participants indicated that they were more likely to purchase a product if the brand name was comprised of common segments and sequences of segments rather than less common segments and sequences of segments. This result suggests that word-characteristics may influence higher-level cognitive processes, in addition to language-related processes. Furthermore, the benefits of using objective measures of word characteristics in the design of brand names are discussed.

Introduction

In the branch of Psychology known as Psycholinguistics, researchers examine various characteristics of words in an effort to understand how those characteristics influence language-related processes, including the ability to quickly and accurately acquire, produce, recognize, and remember the words of one's language. Among the characteristics of words that Psycholinguists have examined are the frequency with which the word occurs in the language (Soloman & Postman, 1952), the age at which that word was first learned [known as *age-of-acquisition* (AoA); Ellis & Morrison, 1998], *phonotactic probability* (i.e., the frequency with which phonological segments and sequences of segments appear in a word; Vitevitch & Luce, 1998), and *neighborhood density* (i.e., the number of words that sound like that word; Luce & Pisoni, 1998).

It has been known for some time that words that occur frequently in the language are recognized and produced more quickly and accurately than words that occur less frequently in the language (e.g., Soloman & Postman, 1952; Oldfield & Wingfield, 1965). In contrast, other characteristics, such as neighborhood density have been shown to have different influences in different cognitive processes, such as word-learning (Storkel, 2004), word production (Vitevitch, 2002), word recognition (Luce & Pisoni, 1998), and verbal short-term memory (Roodenrys, Hulme, Lethbridge, Hinton, & Nimmo, 2002). It is therefore important to examine the influence of various word-characteristics in a variety of cognitive processes and domains.

In addition to influencing basic cognitive processes (e.g., learning, production, recognition, and short-term memory), recent findings suggest that these and other word-characteristics may also influence processing of language-related information in applied domains (e.g., Hennessey, Bell, & Kwortnik, 2005). Consider, for example, the work by Lambert et al. (2010) examining how neighborhood density influences the number and types of errors made by physicians, nurses, pharmacists, and patients when identifying drug-names. In these studies, neighborhood density was defined as the number of drug-names (rather than words in the language) that sounded like a given drug-name. As in

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Published online: 26 August 2011

the case of real English words (Luce & Pisoni, 1998; see Vitevitch & Rodriguez, 2005 for different effects in Spanish), drug names that sounded like many other drug names were more likely to be misidentified than drug names that sounded like few other drug names. Identifying how word-characteristics such as neighborhood density influence prescription errors not only has practical implications for reducing those errors (Lambert, 1997), but also for the initial branding of the drug. By designing a drug name that is unique from other drug names on the market, the likelihood that a prescription error involving that drug might be reduced (Lambert, Lin, & Tan, 2005).

Recent findings also suggest that word-characteristics might influence other cognitive processes and higher-level decisions. Ellis, Holmes, and Wright (2010) demonstrated that brand-names, like real words in English, that are learned early in life (i.e., have an early AoA) were recognized more quickly than brand-names acquired later in life. More interesting was the finding that semantic knowledge (e.g., was the brand-name a type of chocolate bar, aftershave, etc.) for early acquired brand-names was also accessed from memory more quickly than semantic information for brand-names acquired later in life, suggesting that word-characteristics (or in this case, the characteristics of brand-names) can influence higher-level cognitive processes, not just those processes involved in the initial perception of that word or brand name.

The work of Song and Schwarz (2009) further suggests that characteristics of a brand name might influence higher-level cognitive processes, such as those processes involved in assessing perceived risk. In three experiments, Song and Schwarz (2009) found that participants rated names that were difficult to pronounce as being more harmful food additives (Experiments 1, 2), and as being riskier amusement rides (Experiment 3) than names that were easier to pronounce. Song and Schwarz (2009) further speculated that intentionally designing product names that were difficult to pronounce might alert consumers to the risks posed by a potentially hazardous product, and motivate consumers to pay closer attention to warnings and instructions.

In the present study, we directly examined the influence of potential brand name-characteristics on attitudes related to product consumption. In the studies by Song and Schwarz (2009) ease of pronouncing the names was assessed by *subjective* ratings obtained from another set of participants. Rather than use only subjective ratings of the names, we *objectively* measured the phonotactic probability of the potential product names. Phonotactic probability refers to the frequency with which a phonological segment, such as /s/, and a sequence of phonological segments, such as /s^/, occur in a given position in a word (Jusczyk, Luce, & Charles-Luce, 1994). This objective measure of frequency of occurrence is calculated by summing the frequency of all the words that contain a given segment (or sequence of segments), and dividing by the summed frequency counts for all the words in the dictionary that have a segment (or sequence of segments) in that position to produce a token-based probability estimate of that segment (or sequence of segments). (More details for how phonotactic probability is calculated can be found in Vitevitch and Luce (2004), as can the URL for an on-line tool that can be used to objectively assess phonotactic probability.)

Previous psycholinguistic research showed that specially constructed nonwords with high phonotactic probability tend to be rated as sounding more like English words than nonwords with low phonotactic probability (Vitevitch, Luce, Charles-Luce, & Kemmerer, 1997). Furthermore, in a variety of language-related processing tasks, nonwords with high phonotactic probability were responded to more quickly and accurately than nonwords with low phonotactic probability (Vitevitch & Luce, 1998, 1999). Moreover, Gathercole, Frankish, Pickering, and Peaker (1999) found in tests of short-term memory, that nonwords with high phonotactic probability were recalled more accurately than nonwords with low phonotactic probability. Together these findings suggest that the objective measure of phonotactic probability successfully predicts performance in a variety of language-related cognitive processes.

To examine whether phonotactic probability successfully predicts performance in a higher-level cognitive process, such as the decision process used when choosing to purchase a product, we explicitly asked participants in the present experiment to rate how likely they were to purchase a product with a specially constructed name that varied in phonotactic probability. This approach offered a direct assessment of the influence of a word-characteristic (that was measured objectively rather than subjectively) on higher-level attitudes and behaviors of the consumer than was afforded by previous studies. In a separate task we asked the same participants to rate how much each nonword sounded like a real word in English, which allowed us to also examine the relationship between subjective measures of word-characteristics and objective measures of word-characteristics (Vitevitch et al., 1997), and between subjective measures of word-characteristics and higher-level attitudes and behaviors of the consumer.

We recognize that the domain we investigated in the present study—the decision process used when choosing to purchase a product—has obvious application to commercial and business domains. Our intent, however, was not simply to apply basic research findings to a real-world domain. Rather, we wished to examine how certain word-characteristics might influence the complex, higher-level cognitive process of deciding to purchase a product—a process in which less than optimal decision-making and irrational choices are sometimes made (e.g., consider for example the success of the VHS video tape format over the higher picture-quality Betamax video tape format in the late twentieth century). The less than optimal and apparent irrational nature of the higher-level processes associated with deciding to purchase a product contrasts with the (near) optimal performance associated with fundamental memory and language processes. Therefore, the present study represents a shift in the focus of basic research to a new area of cognitive processing influenced by a wider variety of internal and external factors, not a shift from basic research to applied research.[1]

Methods

Participants

Nineteen participants were recruited from General Psychology courses taught at the University of Kansas. Participants reported that they were native speakers of English, and had no history of speech or hearing disorders. Compensation was given in the form of credit toward a course requirement for all participants.

Materials

The 60 consonant-vowel-consonant, monosyllabic nonwords (30 with high phonotactic probability, 30 with low phonotactic probability) used in Vitevitch and Luce (2005) served as stimuli in the present experiment. These items appear in the Appendix. The phonotactic probabilities for the stimuli were calculated using the Phonotactic Probability Calculator (Vitevitch & Luce, 2004). For high phonotactic probability nonwords, both the sum of segments (mean = 0.167, SEM = 0.004) and the sum of sequences of segments (mean = 0.086, SEM = 0.004) were both significantly higher [$F(1, 58) = 193.57$, $P < 0.0001$] than the sum of segments (mean = 0.008, SEM = 0.001) and sum of sequences of segments (mean = 0.001, SEM = 0.0001) for the low phonotactic probability nonwords.

An equal number of nonwords in each condition contained the same initial consonants (3 nonwords each started with /b/, /d/, /f/, /g/, /ʤ/, /m/, /n/, /p/, /r/, /t/). The stimuli were recorded in an IAC sound attenuated booth using a high quality microphone at a sampling rate of 44.1 kHz, and later edited into individual computer files (16 bit).

Procedure

Participants were seated in front of an iMac running PsyScope 1.2.5 (Cohen, MacWhinney, Flatt, & Provost, 1993), which was used to present instructions, randomize and present stimuli, as well as record responses. Participants were instructed that the experiment would consist of two rating tasks. Both rating tasks used a 7-point Likert scale. In the word-likeness task participants were asked to rate how well each stimulus sounded like an English word. The value of 1 corresponded to "Bad English word" and the value of 7 corresponded to "Good English word." In the purchasing behavior rating task participants were asked to rate how likely they would be to buy a product, based on the name alone. The value of 1 corresponded to "least likely to buy," and the value of 7 corresponded to "most likely to buy." The order of the tasks was counterbalanced to minimize order effects.

Each trial began with the word "Ready" appearing on the screen for 500 ms, followed by the random presentation of a stimulus over Beyer dynamic DT100 headphones at a comfortable listening level (approximately 65 db). After the participant responded with a number between 1 and 7, and hit the return-key on the computer keyboard, the next trial began.

Results and discussion

Previous studies have shown that listeners subjectively rate specially constructed nonwords with high values of objectively measured phonotactic probability as sounding more like English words than specially constructed nonwords with low values of phonotactic probability (Vitevitch et al., 1997). Similar results were obtained in the present experiment. Word-likeness ratings were significantly and positively correlated with both objective measures of phonotactic probability: sum of the segments [$r = 0.55$, $z\ (60) = 4.72$, $P < 0.0001$], and sum of the biphones [$r = 0.56$, $z\ (60) = 4.80$, $P < 0.0001$]. Note that the study by Vitevitch et al. (1997) used nonwords that contained two syllables, whereas the present study employed monosyllabic nonwords. Therefore, the present

[1] Brand names themselves also warrant some attention from Psycholinguists and other Cognitive Scientists, because of the interesting ways in which they differ from more conventional words and proper names. For example, brand names, like real words and proper names, consist of a lexeme (i.e., the "word" or "name") and a lemma (i.e., the referent, or the semantic or conceptual meaning). However, brand names also represent perceptions and opinions about the products they are associated with, have a "value" in the marketplace that can fluctuate over time, and can be used to indicate social status or affect one's self-esteem. Furthermore, brand names not only differentiate one product from a similar product in the market, but they also can be used—in what appears to be circular logic—to justify a purchase decision (e.g., I bought this printer instead of that nearly identical printer because this printer is "Brand X" and that printer is not). Direct investigation of brand-names themselves is beyond the scope of the present investigation, however.

findings represent an important replication of previously observed results.

We also found that the subjective ratings of word-likeness for a given item significantly correlated with ratings of likelihood to buy a product with that name [$r = 0.70$, $z\,(60) = 6.57$, $P < 0.0001$]. That is, nonwords that sounded more like an English word also had names that made it more likely a listener would purchase a product with that brand name, whereas nonwords that sounded less like an English word had names that made it less likely a listener would purchase a product with that brand name. This result suggests that higher-level cognitive processes can be influenced by word-characteristics related to how easily the brand name can be pronounced, and is consistent with the findings by Song and Schwarz (2009), who used subjective ratings of ease of pronunciation and risk perception of specially created product names. Together these results suggest that subjectively measured characteristics about words or brand names influence higher-level cognitive processes.

Of primary interest in the present study is the significant correlation between the objective measures of phonotactic probability of the brand names and the subjective ratings of likelihood to buy a product with that brand name. Both objective measures of phonotactic probability were significantly and positively correlated with the subjective ratings of likelihood to buy a product with that brand name: sum of the segments [$r = 0.51$, $z\,(60) = 4.27$, $P < 0.0001$], and sum of the biphones [$r = 0.48$, $z\ (60) = 3.98$, $P < 0.0001$]. The present results suggest that phonotactic probability influences higher-level cognitive processes, like those involved in deciding to buy a consumer product, in addition to influencing the initial perception and linguistic processing of nonwords (as demonstrated by Vitevitch & Luce, 2005).

The demonstration that objective measures of word characteristics—specifically phonotactic probability—influence higher-level decisions is important for at least two reasons. First, word-characteristics that were previously thought to influence only language-related processes also affect other cognitive processes (i.e., the decision process involved in whether to buy a product or not). This finding lends some credence to the contested Sapir-Whorf hypothesis, which suggests that language usage influences other cognitive processes (see also de Saussure, 1966).

Second, these findings demonstrate that objective measures rather than subjective measures of words (as in Song & Schwarz, 2009) can be used to assess how a word is pronounced might influence higher-level cognitive processes. Although the subjective ratings of word-likeness in the present experiment accounted for more variance ($r^2 = 0.49$) than the objective measures of phonotactic probability ($r^2 = 0.26$), objective measures of word-characteristics are widely and freely available for use (e.g., Vitevitch & Luce, 2004). In contrast, reliable subjective ratings require adequate sample sizes or multiple measures from the same individuals (Herzog & Hertwig, 2009; Vul & Pashler, 2008). Furthermore, objective measures of word characteristics can be obtained easily for large sets of potential product names, whereas if one wishes to evaluate a large number of potential product names, one must be concerned about fatigue influencing participant responses in a subjective rating task. Therefore, objective measures of word-characteristics offer an easy, quick, and inexpensive method to assess potential brand names.

Although a number of brand names are monosyllabic (nonce) words [e.g., Dodge Ram (automobile), (Chevrolet) Volt (automobile), Skoal (tobacco product), GAP (line of clothing and store), Surf (detergent), (Nintendo) Wii (video game system), Crest (toothpaste)], there are many brand names that are multisyllabic. Given that Vitevitch et al. (1997) found that the phonotactic probability of specially constructed bisyllabic words influenced word-likeness ratings—much like the phonotactic probability of specially constructed monosyllabic words influenced word-likeness ratings in the present study—it would be surprising if a similar relationship between phonotactic probability and purchase likelihood were not observed in longer brand names. We leave this issue for future research, however.

The significant correlation between phonotactic probability of brand names and ratings of likelihood to buy a product with that name also suggests there are a number of issues to consider when designing brand names. Recall Lambert et al. (2010) found that drug-names that were similar to many other drug-names were more likely to be involved in a prescription error than drug-names that were similar to few other drug-names; the number of similar sounding drug-names is often referred to as neighborhood density. Vitevitch, Luce, Pisoni, and Auer (1999) found a significant correlation between neighborhood density and phonotactic probability for real words in English. Real English words that had many similar sounding words (a dense neighborhood) tended to be comprised of segments and sequences of segments that occurred often in the language (high phonotactic probability), whereas real English words that had few similar sounding words (a sparse neighborhood) tended to be comprised of segments and sequences of segments that occurred less often in the language (low phonotactic probability). Thus, there are a number of factors involved in finding a brand name that maximizes the likelihood that a consumer will be interested in purchasing the product (i.e., it has high phonotactic probability), while minimizing the confusability of that name with other products on the market (i.e., it has a sparse neighborhood).

Future studies in which neighborhood density and phonotactic probability are independently and parametrically manipulated (e.g., Storkel & Lee, 2011; Vitevitch, et al.

2004) may be required to determine the location of a brand name "sweet spot" that maximizes consumer appeal, while minimizing problems related to the discrimination of the product from other related products. Additional studies might also examine how neighborhood density and phonotactic probability influence (1) the acquisition of brand names, much like Storkel and Hoover (2011) have examined how these characteristics influence the acquisition of real words, or (2) recall of brand names, much like Roodenrys et al. (2002) has examined how these characteristics influence the memory for real words.

Admittedly, there are many characteristics that influence the success of a product with a given brand name. Some of those characteristics are related to the name (e.g., the descriptive or evocative nature of the name), while other characteristics are related to the product itself (e.g., utility, quality, packaging, and price, etc.). The results of the present experiment found that one factor—phonotactic probability—accounts for a small, but statistically significant amount of variance in the likelihood that a product will be purchased. This observation is important for developing brand names that have a higher likelihood of being successful in the market, especially in tough economic times, and may be useful in developing automatic brand name generators (e.g., http://business-name-generators.com or http://www.netsubstance.com) that produce successful brand names.

Acknowledgments This research was supported in part by grants from the National Institutes of Health to the University of Kansas through the Schiefelbusch Institute for Life Span Studies (National Institute on Deafness and Other Communication Disorders (NIDCD) R01 DC 006472), the Mental Retardation and Developmental Disabilities Research Center (National Institute of Child Health and Human Development P30 HD002528), and the Center for Biobehavioral Neurosciences in Communication Disorders (NIDCD P30 DC005803).

Appendix

The stimulus items used in the present experiment (from Vitevitch & Luce, 2005). The words are transcribed using the computer-readable symbols described in Vitevitch and Luce (2004).

High phonotactic probability	Low phonotactic probability
b@z	bcS
bEs	bRS
bIT	bYJ
dEm	dcb
des	deD
d^p	dRf
fIm	fOz
fYd	fRp
fYs	fWC
gEl	gRp
gId	gWb
gYn	gYT
J@d	JeS
JIt	JRS
Jor	JYg
mEk	mOk
mos	mRz
mWn	mWb
nEs	nES
nId	nRg
n^s	nWb
pim	pRg
pIz	pUC
pYd	puJ
rEn	rOk
rEs	rWb
rIz	r^D
t@s	teS
tes	toJ
tIC	tWz

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