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Phonographic neighbors not orthographic neighbors determine word naming latencies

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Abstract

The orthographic neighborhood size (N) of a word, the number of words that can be formed from that word by replacing one letter with another in its place, has been found to have facilitatory effects in word naming. The orthographic neighborhood hypothesis attributes this facilitation to interactive effects. A phonographic neighborhood hypothesis, in contrast, attributes the effect to lexical print-sound conversion. According to the phonographic neighborhood hypothesis, phonographic neighbors (words differing in one letter and one phoneme, e.g., stove and stone) should facilitate naming and other orthographic neighbors (e.g., stove and shove) should not. The predictions of these two hypotheses are tested. Unique facilitatory phonographic N effects were found in four sets of word naming mega-study data, along with an absence of facilitatory orthographic N effects. These results implicate print-sound conversion, based on consistent phonology, in neighborhood effects, rather than word-letter feedback.

Phonographic neighbors not orthographic neighbors determine word naming latencies

The orthographic neighborhood of a word is defined as the set of words that may be formed from it by replacing only one letter with another in the same position. The effect of the size of this neighborhood (*N*, Coltheart, Davelaar, Jonasson, & Besner, 1977) on the speed of lexical processing has been examined in many experiments (for reviews, see Andrews, 1997; Mathey, 2001). Andrews (1997) and Mathey (2001) both concluded that large values of orthographic N are associated with fast word naming. Specific evidence as to the source of this effect would constrain word recognition models. Some accounts attribute N effects to purely orthographic interactive-activation processes (Andrews, 1989, 1997). In contrast, as discussed below, several models of word recognition attribute N effects to a print-sound conversion process -- orthographic neighbors tend to have similar pronunciations, and so the effect is not one of orthographic neighbors per se (see Peereman & Content, 1995, for discussion of alternative hypotheses and data from French pseudoword and word naming). Evidence for the former interpretation would be difficult to accommodate within current models, as such interactions have little effect on the word level in some (e.g Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001) or are absent from the model in others (e.g Plaut, McClelland, Seidenberg, & Patterson, 1996). Here we test between the competing explanations of *N* effects.

When Andrews (1989) first found an effect of orthographic *N* on word naming for low-frequency words, she interpreted this in terms of the `gang effects' occurring in McClelland and Rumelhart's (1981) interactive-activation (IA) model of visual word recognition, originally used to account for word-superiority effects in the Reicher-Wheeler paradigm (Reicher, 1969; Wheeler, 1970). She argued that processing units for words differing in one letter from the target would receive moderate (spurious) activation in the early stages of word recognition, which would feed back to (mostly) correct letter units, increasing their activation, and in turn speeding the recognition of the correct word. Thus, words with many orthographic neighbors would be named faster than those with few. Although Jacobs and Grainger (1992) failed to find such an effect in an IA model, such effects are highly dependent on parameter values, and can be found in related models with appropriate parameters (Reynolds & Besner, 2002). Andrews (1989, 1997) has argued that a lexical identification account is most parsimonious because it may also account for the word-superiority effect, as well as a facilitatory effect of orthographic *N* in lexical decision (Andrews, 1989, 1992, 1997).

However, an alternative account is not only possible but is assumed by many current models. The DRC model of Coltheart et al. (2001) accounts for neighborhood effects by the action of its IA-based lexical route. Coltheart et al. (2001) cite the connections between orthographic word units and phonological word units, and the cascade into phonemes, in this route as causing facilitatory *N* effects for word and pseudoword naming, although they need to alter parameter values to find such an effect for words. With this modified parameter set, Reynolds and Besner (2002) have confirmed using lesion methods that the effect for words is in fact due to these connections alone; that is, lexical print-sound correspondences bring about effects of orthographic *N*. This explanation therefore is not one purely in terms of orthographic identification; rather, it relies upon the orthographic neighbors of a word activating the same phonemes as that word.

Similarly, other computational models of visual word recognition, excepting those which have assume all-or-nothing lexical access, can only account for *N* effects as due to print-sound correspondences. This is because they do not have orthographic word representations; rather, letters are processed immediately into intermediate or phonemic representations. Such models include parallel-distributed processing (PDP) models (e.g., Seidenberg & McClelland, 1989; Plaut et al., 1996; Zorzi, Houghton, & Butterworth, 1998) and retrieval models (e.g., Kwantes & Mewhort, 1999). Moreover, PDP models do produce orthographic neighborhood size effects (Sears, Hino, & Lupker, 1999).

Thus, there are two competing hypotheses regarding the source of orthographic *N* effects. The orthographic neighborhood hypothesis states that facilitation from orthographic *N* results from purely orthographic facilitation of word identification. The phonographic-orthographic or phonographic neighborhood hypothesis (cf. Peereman & Content, 1997) states that facilitation from orthographic neighborhood size occurs because phonology consistent with the desired phonology is activated by most of the orthographic neighbors, and thus is not purely orthographic.

Despite the widespread theoretical assumption that orthographic N effects are due to print-sound conversion at the lexical level, there is almost no direct evidence to support the claim, especially in English. In regression analyses of their naming results on ninety-two French words, Peereman and Content (1995) divided the orthographic neighbors into those which were also phonological neighbors (i.e., could be generated from the word by replacing one phoneme) and those which were not, and concluded that only those which were also phonologically similar contributed to the *N* effect. However, the sample was small, and the regression did not control for known predictors of naming latencies aside from those relating to neighborhoods, including orthographic length, which correlates with neighborhood size. Peereman and Content argue specifically that the effects are due to lexical (whole-word) rather than sublexical print-sound conversion, since introducing pseudowords into the context, which should entail a strategic preference for (or focussed attention upon) sublexical correspondences, decreases the *N* effect. This effect does not however exclude a role for sublexical grapheme-phoneme correspondence rules, as it may reflect a shift in time criterion rather than route emphasis (e.g., Chateau & Lupker, 2003).

The orthographic neighbors that are also phonological neighbors were termed phonographic neighbors by Peereman and Content (1997). For instance (in English) shove and stone are both orthographic neighbors of stove, but only stone is also its phonographic neighbor (since it is a phonological neighbor). Moreover, like stone, stoat is a phonological neighbor of stove, but it is not its phonographic neighbor (since it is not an orthographic neighbor). Although Yates

(2005) has found evidence for phonological neighborhood effects in naming, and Yates, Lawrence Locker, and Simpson (2004) have suggested that some orthographic neighborhood effects might be due to phonological neighborhood, no evidence has been adduced for the latter point beyond the existence of the confound between the variables. Phonographic neighbors (rather than simply phonological neighbors) are of concern in the current paper, since it is these that should be the cause of neighborhood effects according to the phonographic neighborhood hypothesis.

Peereman and Content (1997) analyzed these phonographic neighbors by comparing naming latencies for French pseudowords which varied in phonographic neighborhood size, controlling orthographic neighborhood size (having shown that phonological neighborhood size has no effect). Despite this control on orthographic *N*, there was a facilitatory effect of phonographic *N*. However, they did not seek an orthographic neighborhood effect with phonographic neighborhood size controlled. From further experiments, they concluded that the effect was isolated to those neighbors whose difference was in the onset of the word[1]. In effect, this meant they were manipulating number of friends (i.e., words that share both orthographic and phonological vowel and coda, although complex onsets mean that friends need not be phonographic neighbors). They also showed a facilitatory effect of friends for French words, replicating the result in English of Kay and Bishop (1987) and Brown (1987). Their conclusion that rimes are critical is surprising, given that their regression on their previous experiment with French words (Peereman & Content, 1995) showed no unique effect for these. Moreover, their experiments do not rule out an effect of other kinds of neighbors for words. Further, it is not clear that effects for pseudowords, which do not have a stored phonological representation, will necessarily generalize to words.

Currently, from mega-study data regarding English words, there is no evidence that higher-level segmental spelling-sound correspondences, that is, consistencies, are the cause of orthographic neighborhood effects in naming. Balota, Cortese, Sergent-Marshall, Spieler, and Yap (2004) entered both feed-forward and feed-backward consistency variables based on orthographic segments (onset, rime) into their analyses, but continued to find orthographic neighborhood effects.

According to the phonographic neighborhood hypothesis, this might not indicate that apparent orthographic neighborhood effects are due to something other than lexical spelling-sound correspondences, but rather that these kinds of measurement of lexical spelling-sound correspondence are too fine (are defined by similarities over too small a portion of the word). A further competing alternative is that the correspondences represented in these consistency variables are too coarse and it is grapheme-phoneme correspondences that drive orthographic *N* effects.

The availability of mega-study data is crucial in situations such as this where predictors are difficult to manipulate factorially. Attempts to manipulate similar variables whilst controlling others result in small sets of stimuli (cf. Cutler, 1981) with insufficient power to detect effects. This is the case when comparing orthographic neighborhood size and phonographic neighborhood size; matched pairs of stimuli that do not differ on other spelling-sound measures are few in English. With large sets of data containing many words, variables not of interest can be covaried out of the analyses and power increased by the use of many items that would otherwise have to be ignored.

The orthographic and phonographic hypotheses regarding neighborhood facilitation in English word naming were therefore tested in the present work using word naming data from four mega-studies. Since there could be effects of orthographic and phonographic neighbors from different sources, both phonographic and orthographic neighborhood size effects were sought. Finding a phonographic but not orthographic neighborhood effect would confirm the phonographic neighborhood hypothesis, indicating that the word-letter feedback invoked by Andrews (1989) does not account for neighborhood effects.

Analyses

To assess the extent to which orthographic and phonographic neighbors affect word naming, we conducted regression analyses that assess the unique influence of each variable when it is entered last (this is equivalent to simultaneous regression).

Predictors

Predictors in the regression analyses were (where necessary and not otherwise specified, from CELEX: Baayen, Piepenbrock, & Gulikers, 1995):

- log of frequency plus one,
- orthographic neighborhood size,
- phonographic neighborhood size, that is, the count of orthographic neighbors whose phonology could be formed by changing at most one phoneme,
- first phoneme, as a (dummy-coded) factor with 38 levels (no attempt was made to code phonetic features),
- length (in letters),
- exception cost by position of irregularity, following the DRC model (Coltheart et al., 2001), as a (dummy-coded) factor with 6 levels (regular, and five positions of irregularity),
- number of friends (words that look as though they rhyme, and do),
- number of enemies (words that look as though they rhyme, and do not), and
- types rime consistency ratio (i.e., friends divided by [friends plus enemies]).

Any effect of Body N[1], which is defined as the sum of number of friends and number of enemies, would be subsumed by the joint effects of number of friends and number of enemies in this type of analysis.

Summary statistics for the predictors (and response time measures described later) are in Table 1. Correlations are presented in Table 2. Orthographic *N* correlates highly with phonographic *N*, but only 630 (23.2%) of the words had identical orthographic and phonographic *N*s. The high correlation causes only higher error in estimates, not bias, and does not modify the probability of a Type I error. The negative effects on power that can result are mitigated by the large sample sizes in the analyses we report here.

Response Times

Item mean response times were taken from the data of Spieler and Balota (1997, SB98) and Balota and Spieler (1998, BS99) for 2720 monosyllabic words (those with all the variables above) in the training set of the Plaut et al. (1996) model. Mean response times for the same words were also extracted when available from the data of Seidenberg and Waters (1989, SW89) (2693 words) and Elexicon (Balota, Cortese, et al., 2002; Balota, Yap, et al., in press; 2667 words). Summary statistics are presented in Table 1.

Results

Raw correlations are presented in Table 2. Table 3 show the results of the regression analyses. There is a significant unique facilitatory effect of phonographic *N*, but not of orthographic *N*, across all four sets of data. The only evidence for an effect of orthographic *N* was for an inhibitory effect in the SW89 data. Given the evidence that suggests an interaction between frequency and *N*, we conducted analyses that tested for orthographic N effects by testing the improvement in R^2 from entering orthographic *N* and its interaction with log frequency simultaneously as a block, and phonographic *N* effects with an analogous phonographic *N* block. For all four data sets, the phonographic *N* block had a significant effect after orthographic N and its interaction with log frequency ($F(2, *) > 6$, $p < .05$), and the orthographic *N* block did not have such an effect ($F(2, *) < 2.1$, $p > .12$).

Discussion

In regression analyses on four sets of data, a facilitatory effect of phonographic *N* was observed in English, concurring with Peereman and Content's (1995) regression on their experiment with French words, and their later (Peereman & Content, 1997) experiments with nonwords. Moreover, this occurred in the absence of any additional facilitation from other orthographic neighbors. This reliance on consistency between similar orthography and similar phonology implicates print-sound conversion processes. Moreover, this effect appeared to be over and above those of regularity and rime consistency, as these were partialed out in the analyses.

These results contradict the orthographic neighborhood hypothesis that neighborhood effects result from interactions at purely orthographic levels. By contrast, the results are as would be expected from a number of models of visual word recognition. The primary constraint arising is that generalization of print-sound correspondence can be influenced by individual words. This arises in IA models (e.g., McClelland & Rumelhart, 1981), and the IA-based portion of the DRC (Coltheart et al., 2001); as a consequence of the error arising from individual words in backpropagation PDP models (e.g., Seidenberg & McClelland, 1989; Plaut et al., 1996; Zorzi et al., 1998); and from the retrieval of individual words in memory-based models (e.g., Kwantes & Mewhort, 1999).

Given that it appears that orthographic neighbors of a word aid its naming only insofar as they closely support the correct pronunciation of this word (by being phonological, and hence phonographic, neighbors) it is perhaps surprising that there is little or no inhibitory effect of orthographic *N* once phonographic *N* is controlled. Such inhibition might be expected because the additional orthographic neighbors support incorrect pronunciations of the target word; if phonographic neighbors are activated on the basis of the orthographic input, so should all other orthographic neighbors. The lack of an inhibitory effect may occur because most of the orthographic neighbors which are not phonological neighbors only differ in two phonemes whose pronunciation they hinder, but give the correct pronunciation for the remainder which they help; this may be almost the correct balance to be equivalent to no neighbor at all. Within this explanation, confusion arising from high neighborhood density, which ordinarily would slow identification per se (cf. Snodgrass & Mintzer, 1993), speeds naming. Alternatively, there may be no competitive inhibition between phonemes or words in normal reading, as in the model of Brown (1987).

Since there is no evidence for an orthographic neighborhood size effect per se, no feedback from word to letter recognition is necessary to account for neighborhood size effects. Moreover, models which lack this kind of feedback, but rather assume that responses in letter identification can be augmented by word identification in a feedforward manner (e.g., Paap, Newsome, McDonald, & Schvaneveldt, 1982) can predict word-superiority in the Reicher-Wheeler task. If such word identification occurs independently, we would have neighborhood size facilitation of pronunciation without such facilitation of identification. Indeed, one would expect neighborhood effects to occur in processing before full identification is possible, that is, where confusion is possible or likely.

It has been shown that in word naming, neighborhood size effects should be considered in terms of phonographic, rather than orthographic neighbors. As such, print-sound consistency, and hence print-sound conversion, is implicated as the source of these effects, rather than orthographic feedback. Such conversion could be based on the result of orthographically similar words competing for identification and influencing pronunciation before correct identification is complete.

References

Andrews, S. (1989). Frequency and neighborhood effects on lexical access: Activation or search? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*, 802-814.

Andrews, S. (1992). Frequency and neighborhood effects on lexical access: Lexical similarity or orthographic redundancy? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 234-254.

Andrews, S. (1997). The effect of orthographic similarity on lexical retrieval: Resolving neighborhood conflicts. *Psychonomic Bulletin & Review, 4*, 439-461.

Baayen, R. H., Piepenbrock, R., & Gulikers, L. (1995). *The CELEX Lexical Database* (Release 2) [CD-ROM]. Philadelphia: Linguistic Data Consortium, University of Pennsylvania.

Balota, D. A., Cortese, M. J., Hutchison, K. A., Neely, J. H., Nelson, D., Simpson, G. B., et al. (2000). *The English Lexicon Project: A web-based repository of descriptive and behavioral measures for 40,481 English words and nonwords.* Retrieved 11th December, 2004 from http://elexicon.wustl.edu/ .

Balota, D. A., Cortese, M. J., Sergent-Marshall, S. D., Spieler, D. H., & Yap, M. J. (2004). Visual word recognition of single-syllable words. *Journal of Experimental Psychology: General, 133*, 283-316.

Balota, D. A., & Spieler, D. H. (1998). The utility of item-level analyses in model evaluation: A reply to Seidenberg and Plaut. *Psychological Science, 9*, 238-240.

Balota, D. A., Yap, M. J., Cortese, M. J., Hutchison, K. I., Kessler, B., Loftis, B., et al. (in press). The English Lexicon Project. *Behavior Research Methods.*

Brown, G. D. A. (1987). Resolving inconsistency: A computational model of word naming. *Journal of Memory and Language, 26*, 1-23.

Chateau, D., & Lupker, S. J. (2003). Strategic effects in word naming: Examining the route-emphasis and time-criterion accounts. *Journal of Experimental Psychology: Human Perception and Performance, 29*, 139-151.

Coltheart, M., Davelaar, E., Jonasson, J. T., & Besner, D. (1977). Access to the internal lexicon. In S. Dornič (Ed.), *Attention and performance VI* (pp. 535-555). Hillsdale, NJ: Erlbaum.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: A dual route cascaded model of visual word recognition and reading aloud. *Psychological Review, 108*, 204-256.

Cutler, A. (1981). Making up materials is a confounded nuisance, or: Will we be able to run any psycholinguistic experiments at all in 1990? *Cognition, 10*, 65-70.

Jacobs, A. M., & Grainger, J. (1992). Testing a semistochastic variant of the interactive activation model in different word recognition experiments. *Journal of Experimental Psychology: Human Perception and Performance, 18*, 1174-1188.

Kay, J., & Bishop, D. (1987). Anatomical differences between nose, palm, and foot, or, the body in question: Further dissection of the processes of sub-lexical spelling-sound translation. In M. Coltheart (Ed.), *Attention and performance XII: The psychology of reading* (pp. 449-469). Hillsdale, NJ: Erlbaum.

Kwantes, P., & Mewhort, D. J. (1999). Modeling lexical decision and word naming as a retrieval process. *Canadian Journal of Experimental Psychology, 53*, 306-315.

Mathey, S. (2001). L'influence du voisinage orthographique lors de la reconnaisance des mots écrits [The influence of orthographic neighbourhood on visual word recognition]. *Revue Canadienne de Psychologie Expérimentale/Canadian Journal of Experimental Psychology*, 55, 1-23.

McClelland, J. L., & Rumelhart, D. E. (1981). An interactive activation model of context effects in letter perception: Part 1. An account of basic findings. *Psychological Review, 88*, 375-407.

Paap, K. R., Newsome, S. L., McDonald, J. E., & Schvaneveldt, R. W. (1982). An activation-verification model for letter and word recognition: The word-superiority effect. *Psychological Review, 89*, 573-594.

Peereman, R., & Content, A. (1995). Neighborhood size effect in naming: Lexical activation or sublexical correspondences? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 409-421.

Peereman, R., & Content, A. (1997). Orthographic and phonological neighborhoods in naming: Not all neighbors are equally influential in orthographic space. *Journal of Memory and Language, 37*, 382-410.

Plaut, D. C., McClelland, J. L., Seidenberg, M. S., & Patterson, K. (1996). Understanding normal and impaired reading: Computational principles in quasi-regular domains. *Psychological Review, 103*, 56-115.

Reicher, G. M. (1969). Perceptual recognition as a function of meaningfulness of stimulus material. *Journal of Experimental Psychology, 81*, 275-280.

Reynolds, M., & Besner, D. (2002). Neighbourhood density effects in reading aloud: New insights from simulations with the DRC model. *Canadian Journal of Experimental Psychology, 56*, 310-318.

Sears, C. R., Hino, Y., & Lupker, S. J. (1999). Orthographic neighbourhood effects in parallel distributed processing models. *Canadian Journal of Experimental Psychology, 53*, 220-229.

Seidenberg, M. S., & McClelland, J. L. (1989). A distributed, developmental model of word recognition and naming. *Psychological Review, 96*, 523-568.

Seidenberg, M. S., & Waters, G. S. (1989). Word recognition and naming: A mega study. *Bulletin of the Psychonomic Society,* 27, 489.

Snodgrass, J. G., & Mintzer, M. (1993). Neighborhood effects in visual word recognition: Facilitatory or inhibitory? *Memory & Cognition, 21*, 247-266.

Spieler, D. H., & Balota, D. A. (1997). Bringing computational models of word naming down to the item level. *Psychological Science, 8*, 411-416.

Wheeler, D. D. (1970). Processes in word recognition. *Cognitive Psychology, 1*, 59-85.

Yates, M. (2005). Phonological neighbors speed visual word processing: Evidence from multiple tasks. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*, 1385-1397.

Yates, M., Lawrence Locker, J., & Simpson, G. B. (2004). The influence of phonological neighborhood on visual word perception. *Psychonomic Bulletin & Review, 11*, 452-457.

Ziegler, J., Perry, C., Jacobs, A., & Braun, M. (2001). Identical words are read differently in different languages. *Psychological Science, 12*, 379-384.

Zorzi, M., Houghton, G., & Butterworth, B. (1998). Two routes or one in reading aloud? A connectionist dual-route model. *Journal of Experimental Psychology: Human Perception and Performance, 24*, 1131-1161.

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Notes

[1] Peereman and Content (1997) term the phonographic neighbors that differ in the onset body neighbors, and consider only those that have simple onsets. Other authors (e.g., Ziegler, Perry, Jacobs, & Braun, 2001) use body N to refer to the number of words that have the same orthographic rime, and we follow the latter, more common, usage later in the paper, although this is inconsistent with the usual idea of a neighbor different in only one unit.

Table 1

Summary statistics for predictor and response variables in the regression analyses

Variable	M	SD
Length	4.360	0.864
Log [Frequency + 1]	5.333	2.048
Orthographic N	8.774	5.803
Phonographic N	6.313	4.660
Number of Friends	10.549	7.256
Number of Enemies	1.375	3.015
Consistency Ratio	.883	0.216
SB98 Young RT (ms)	469.779	21.511
BS99 Older RT (ms)	661.622	37.867
SW89 RT (ms)	569.002	44.147
Elexicon RT (ms)	622.923	52.589

Table 2

Correlations among predictors and between predictors and naming latencies.

		1.	2.	3.	4.	5.	6.	7.
1.	Length	--						
2.	Log[Frequency+1]	-.108	--					
3.	Orthographic N	-.658	.116	--				
4.	Phonographic N	-.580	.056	.895	--			
5.	Friends	-.281	-.002	.474	.539	--		
6.	Enemies	-.048	.152	.114	-.111	-.137	--	
7.	Consistency Ratio	-.033	-.153	.009	.220	.351	-.820	--
	SB98 RT	.378	-.301	-.369	-.353	-.116	-.001	-.042
	BS99 RT	.325	-.384	-.303	-.288	-.125	-.003	-.042
	SW89 RT	.336	-.215	-.301	-.321	-.073	-.005	-.038
	Elexicon RT	.371	-.343	-.333	-.331	-.091	-.001	-.027

Note – Predictor correlations are based on all 2720 words analyzed from the SB98 and BS99 databases.

Table 3

Regression analysis on naming RTs.

Data Set	SB98 Young			BS99 Older			SW89			Elexicon		
Predictor	Effect (ms)	t	Var.	Effect (ms)	t	Var.	Effect (ms)	t	Var.	Effect (ms)	t	Var.
First Phoneme		}	28.44		}	14.33		}	32.07		}	20.83
Length	3.873	7.911 ***	1.07	6.086	6.142 ***	0.85	5.594	5.369 ***	0.53	7.971	6.193 ***	0.76
Log[Frequency + 1]	-2.879	-19.920 ***	6.77	-6.880	-23.518 ***	12.48	-4.000	-12.978 ***	3.10	-8.464	-22.053 ***	9.60
Orthographic N	-0.132	-0.927	0.02	0.074	0.259	0.01	0.593	1.962 *	0.07	-0.326	-0.871	0.01
Phonographic N	-0.708	-4.187 ***	0.30	-0.816	-2.385 *	0.13	-1.439	-3.991 ***	0.29	-0.915	-2.048 *	0.08
Number of Friends	0.205	3.901 ***	0.26	-0.053	-0.497	0.01	0.017	0.154	0.00	0.055	0.396	0.00
Number of Enemies	-0.332	-1.865 +	0.06	-0.535	-1.486	0.05	-0.654	-1.724 +	0.05	-0.148	-0.316	0.00
Consistency Ratio	-8.433	-3.231 **	0.18	-14.335	-2.714 **	0.17	-13.903	-2.499 *	0.11	-11.287	-1.639	0.05
Exception Pos. 1	25.000	8.965 *** }		32.539	5.765 *** }		37.913	6.304 *** }		60.826	8.364 *** }	
Exception Pos. 2	4.408	3.861 *** }		7.086	3.067 ** }		9.429	3.863 *** }		12.485	4.126 *** }	
Exception Pos. 3	4.709	3.049 ** }	2.18	4.211	1.347 }	0.91	3.784	1.140 }	0.98	9.637	2.391 * }	1.78
Exception Pos. 4	0.994	0.324 }		-1.142	-0.184 }		2.525	0.380 }		-15.443	-1.856 + }	
Exception Pos. 5	1.819	0.275 }		8.667	0.646 }		27.334	1.946 + }		30.686	1.778 + }	
Total Variance			54.46			39.81			51.42			48.34

Note: + p < .1 ; * p < .05 ; ** p < .01 ; *** p < .001. Var refers to percentage unique variance accounted for by variable (except in final row).