ListChecker Pro 1.2: A program designed to facilitate creating word lists using the University of South Florida word association norms

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Various areas of research (e.g., memory, metamemory, visual word recognition, associative priming) rely on the careful construction of reliable word lists. ListChecker Pro 1.2 is a computer program that accesses the University of South Florida word association norms (Nelson, McEvoy, & Schreiber, 1998, 2004) to report characteristics of words (e.g., frequency, concreteness), as well as direct and indirect associative relationships (e.g., shared associates, mediators). The present article presents the input requirements, menu options, and output obtained by ListChecker Pro 1.2. In addition, a randomly selected list of words from the associative versus semantic priming literature was submitted to ListChecker Pro 1.2 to demonstrate how seemingly unrelated words can be associated. The zipped file containing the program and database can be downloaded from www.eakinmemorylab.psychology.msstate.edu.

Knowledge about the characteristics of words and their relationships to each other is vital to several areas of research, including memory, metamemory, visual word recognition, and priming. The present article presents ListChecker Pro 1.2, a program designed to help researchers evaluate characteristics of constructed word lists. ListChecker Pro 1.2 accesses normative data represented in the University of South Florida (USF) word association norms (Nelson, McEvoy, & Schreiber, 1998, 2004) to determine characteristics and associative information about words. More information on the USF word association norms can be found at <http://web.usf.edu/FreeAssociation> and in the online supplement for Nelson et al. (2004). The USF norms report characteristic data, such as printed word frequency and concreteness. In addition, the USF norms provide an index of direct and indirect associations among and between words. In essence, the USF norms provide a theoretical structure for the organization of words and their associative relationships (Nelson, McEvoy, & Schreiber, 1998, 2004). ListChecker Pro 1.2 accesses this information and provides reports on the associative relationships among and between lists of words to either examine their impact experimentally (e.g., Eakin & Hertzog, 2006; Nelson, Bennett, & Leibert, 1997; Nelson, McEvoy, & Dennis, 2000; Nelson, McEvoy, & Pointer, 2003; Nelson, McEvoy, & Schreiber, 1998, 2004; Nelson, McKinney, Gee, & Janczura, 1998; Schreiber, 1998; Schreiber & Nelson, 1998) or equate them across other experimental manipulations in order to control for the in-

fluence of extraneous characteristics (e.g., Eakin, 2005; Hertzog, Kidder, Powell-Moman, & Dunlosky, 2002).

A discussion of the types of research for which ListChecker Pro 1.2 facilitates list construction is presented. In addition, the ListChecker Pro 1.2 program is discussed here in detail, and example output is included for each option. First, however, a brief discussion of the types of information provided by the USF norms is provided.

Associative Characteristics Provided by the USF Word Association Norms

Consider a list of words that includes BOY, MOTHER, CHILD, FAST, RAKE, HAPPY, and RUN. According to the USF word association norms (Nelson, McEvoy, & Schreiber, 1998, 2004), words on this list have both explicit direct associations and implicit indirect associations. *Direct associations* can be forward, from the presented word to its associates, or backward, from the associate to the presented word. Figure 1 illustrates some of the associations among words on the list. For instance, CHILD and MOTHER have a forward association strength of .03 and a backward association strength of .01.¹ *Direct associations* are identified in the USF norms as members of a word's associative set. For example, CHILD has an associative set of 15, whereas HAPPY has a relatively small associative set of 8. The association between a word and its set member is a forward association; however, words can serve both as having an associative set and being a member of another

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Figure 1. Schematic of potential associative relationships among words.

word's associative set. In such a case, the backward association is an indication that a word is also a member of the associative set of the word with which it shares a forward association.

Related to set size are two other characteristics of words: resonance and connectivity. *Resonance* refers to the resonant connections from the associates of the word back to the word itself. For example, FRIEND has a large associative set of 22 words, and, when each of those words was separately normed, 15 of them produced FRIEND as an associate, with a total resonance of 5.16. This value is calculated by taking the sum of the association strengths of those 15 members of FRIEND's set that produced it as an associate. *Connectivity* refers to the connections among the associates of the word. For example, the 22 associates of FRIEND, when separately normed, produced 41 associate-to-associate connections.²

In addition to having direct associations, words can be indirectly associated through *mediators* and *shared associates* (formerly called *overlapping associates*). A mediator is a link between words, often associating words that are not directly associated. For instance, although MOTHER and BOY are not directly associated, they are mediated by CHILD, with a strength of .0003 (see note 2). MOTHER and BOY are also indirectly associated via a shared associate. *Shared associates* are associated with both the cue and the target, linking the two, even though they may not be directly related or mediated. FRIEND is a shared associa-

tion of MOTHER and BOY with a shared associate strength of .0003. Note that, although FRIEND is not on the original list, because it shares associations with words that are on the list, it is implicitly present. In fact, FRIEND not only has a large associative set of 22, it is also a member of the associative sets of over 100 words, including some of those on the list. Therefore, FRIEND has the potential to influence experiment outcomes, as will be discussed.

How Word Association Influences Experiment Outcomes

The strength of direct and indirect connections between and among the associates of words, as well as the number of words, or *set size*, of a word, influences memory outcome (e.g., Eakin & Hertzog, 2006; Nelson & McEvoy, 1979; Nelson, McEvoy, & Schreiber, 1990, 1998; Nelson, Schreiber, & McEvoy, 1992; Nelson, Schreiber, & Xu, 1999; Schreiber, 1998). In addition, both resonance and connectivity affect memory similarly; increased resonance and connectivity result in better memory (Nelson et al., 2003). Nelson and Zhang (2000) conducted a simultaneous multiple regression analysis of 29 experiments to determine whether the effects of associative characteristics affected recall. When the correlations among the variables were statistically controlled, each variable served as a significant predictor of recall, and nearly 50% of the variance in cued recall was explained by direct and indirect associations, target connectivity, and the set sizes of the cues and targets. Metamemory or knowledge about one's own memory (Flavell, 1979) is influenced by the number of associates of words in the same way that memory is influenced (e.g., Eakin & Hertzog, 2006, 2010a; Hertzog et al., 2002; Schreiber, 1998; Schreiber & Nelson, 1998; but see Eakin & Hertzog, 2010b). However, memory and metamemory are not the only domains for which consideration of word associations is important.

The number and type of associates also influence visual word recognition. For instance, lexical decision is faster for *pseudohomophones* (nonwords that sound like an actual word; e.g., NALE) with small sets versus those with large sets (Yates, Locker, & Simpson, 2003). In addition, knowledge about the relationships between words is crucial for research on semantic versus associative priming (for reviews, see Hutchinson, 2003; Lucas, 2000; Neely, 1991). Semantic priming is an experimental technique demonstrating that response time to a target word is faster if it is preceded by a related word, or *prime*, than if it is preceded by an unrelated word. For example, response time to indicate that DOCTOR is a word is faster when that word is primed with NURSE than when it is primed with TRUCK. Such research is useful for the understanding of how words are organized and accessed (e.g., Collins & Loftus, 1975; McClelland, 1987; Plaut & Booth, 2000). However, historically, word lists used in semantic priming research were created using word association norms, resulting in confounding between associative and semantic priming. Fischler (1977) made a distinction between semantic and associative priming by indicating that words could be related semantically but not associatively (e.g., NURSE–WIFE) and vice versa; he described the two types

Table 1
Sample Word List Used As Input for ListChecker Pro 1.2

Cue–Target Stimuli List (Also, Option 5 Input List)	Cues (Option 1, 2 Input List)	Targets (Option 1, 2 Input List)
TIGER–CAT	TIGER	CAT
WARRIOR–SOLDIER	WARRIOR	SOLDIER
JOKE–LAUGH	JOKE	LAUGH
THIMBLE–NEEDLE	THIMBLE	NEEDLE
CIRCLE–ROUND	CIRCLE	ROUND
FILM–CAMERA	FILM	CAMERA
TAVERN–PUB	TAVERN	PUB
SOCKET–PLUG	SOCKET	PLUG
MOB–GANG	MOB	GANG
REPTILE–LIZARD	REPTILE	LIZARD

Note—The first column is the potential stimuli list. Option 5 could also be applied to this list. The second and third columns split the cue–target list into separate cue and target input lists. Both Options 1 and 2 could be applied to these lists.

of relationships as being mutually exclusive. Conversely, Steyvers and Tenenbaum (2005) have shown that the average associative path length to get from any one word to any other in the USF norms is three steps, thereby rendering the concept of completely unassociated words suspect. In fact, the USF word association norms indicate that NURSE and WIFE are actually associated via WOMAN. Research on priming frequently uses word lists that contain multiple members of the same taxonomic category (e.g., FATHER, GRANDFATHER—Pécher, Zeelenberg, & Raaijmakers, 1998; and JACKET, TROUSER—Williams, 1996). For example, McRae and Boisvert (1998) demonstrated semantic priming of (presumably) unassociated words (e.g., GOOSE–CHICKEN). Association was determined via norming tasks conducted by the researchers. For words that were semantically similar but not associated, they reported priming effects, especially if the prime and target were highly similar. However, ListChecker Pro 1.2, using information from the USF word association norms, demonstrates that GOOSE and CHICKEN not only are directly associated (albeit weakly) but also are associated via five other words. The purpose of the present article is not to enter the debate on semantic versus associative priming but to demonstrate the importance of using a normative database—specifically the USF word association norms—to examine such factors and to introduce a program that facilitates reporting the characteristics of words in that database.

Although the USF word association norms are an excellent resource, using them to verify associative relationships among and between words on a list can be cumbersome. The purpose of the present article is to describe ListChecker Pro 1.2, a computer program designed to use the normative information represented by the USF word association norms to create accurate word lists for experimental purposes.

LISTCHECKER PRO 1.2

ListChecker Pro 1.2 is a program that consists of an application executable file and a data file containing information from Appendix A of the USF word association

norms (see Nelson et al., 2004, for a description of all of the appendixes). The program is Windows based and performs five operations; these options are described in the following sections. Instructions for running the program are given in a “read me” file attached with the program, although some general points are discussed in the Method section of the present article. Table 1 presents sample input lists for Options 1, 2, and 5; these lists were used in the examples presented throughout this section.

Option 1: Compare Two Lists of Single Words for Shared Associates

Option 1 allows for the comparison of two lists of any length (even a single word) to determine the relationships between the words on the first list and the words on the second list. Option 1 could be used, for example, to construct a list of related cue–target pairs for paired-associate learning, intralist cuing, or priming tasks. Assume that the goal is to create a list of cue–target pairs for which the cue is related to only its intended target. Option 1 could determine the direct and indirect relationships between the cue list and the target list. In addition, Option 1 could show the shared associates and mediators for each set of related pairs. The list of cues serves as the first input list, and the list of targets serves as the second input list. The output file that is created by ListChecker Pro 1.2 is a semicolon-delimited text file that can be opened in Microsoft Excel. A sample output of the comparison done by Option 1 is shown in Figure 2. Each cue is listed in column A, followed by its set size in column B. In column C, the intended target is listed along with the other targets from List 2 for which there are direct and indirect associations with the List 1 cue. The corresponding set sizes are listed in column D. The number of direct associations can be determined from looking at columns E and F, G and H, and I. Column E lists the forward association strength between the cue (e.g., TIGER) and the target listed (e.g., CAT); column F places a “1” in that column to serve as a count of one target for which there is a forward association strength greater than zero. Columns G and H provide the same information regarding any backward association strength from the target to the cue, as well as a count-mark, indicat-

A	B	C	D	E	F	G	H	I	J	K
Cues	Cue Set Size	Targets	Target Set Size	Forward Strength	#Q-T	Backward Strength	#T-Q	#Both	# Shared Associates	# Mediated Associates
TIGER	15	CAT	3	0.154	1	0			1	4
		CAMERA	8	0		0			1	
		LIZARD	21	0		0			1	
10	10.1	19	12.6842	0.123	3	0.0384737	0	7	38	33
# of 0 Assoc.		0								

L	M	N	O	P	Q	R	S	T	U	V
# Potential Non-Normed Mediators	Shared Associate	Mediator	Q-SA	SA-Q	T-SA	SA-T	Q-M	M-Q	T-M	M-T
0	KITTEN		0.014	0	0.16	0.789				
		ANIMAL					0.028	0	0	0.12
		KITTEN					0.014	0	0.16	0.789
		LION					0.308	0.362	0	0.085
		STRIPE					0.077	0.034	0	0.011
0	EYE		0.014	0	0.021	0				
0	ANIMAL		0.028	0	0.054	0				
3			0.095	0.019184	0.120605	0.083184	0.100364	0.067333	0.090455	0.132727

Figure 2. Sample output from Option 1. This figure is a snapshot of the actual output from Option 1 for which the list of cues and list of targets are compared with each other to determine associative relationships among words on the lists. The output is truncated and split for optimal presentation. The bottom rows indicate the total means for all characteristics for all words in the output.

ing that association. Column I provides a count-mark indicating both forward and backward associations between the cue and target—the strengths are listed in columns E and G, respectively.

In addition to being directly associated, TIGER and CAT are also indirectly associated via one shared associate and four mediators. Column J indicates a count of the number of shared associates; column K indicates a count of the number of mediators. Column L indicates the number of potential nonnormed mediators: It is a count of words that were provided as responses to a list item but that have not been submitted to norming themselves. Therefore, they could be mediators, but, as yet, have not been normed. This number is important, because a large number of nonnormed mediators increases the likelihood of underestimating mediator strength. A count for potential nonnormed shared associates is not provided, because nonnormed shared associates do not have an impact on the shared association strength (Nelson, McKinney, et al., 1998). Columns M and N list the shared associate and mediator, respectively. The next eight columns provide the forward and backward association strengths between the cue or target and the shared associate (columns O–R) and between the cue or target and the mediator (columns S–V). Information about the indirect associations is provided both for targets with a direct association to the cue—such as for the TIGER–CAT pair—but also for targets for which only indirect associations exist. For example, TIGER is not directly associated with LIZARD, but the two words are indirectly associated via a shared associate, ANIMAL.

Finally, the last row of the output from Option 1 provides the sums of the count columns and the means of the value columns for each of the characteristics described, in addition to a count of cues and/or targets on the list that have not been normed. (Note that the totals are from the whole report: The report in Figure 2 is truncated to save space.)

Option 2: Compare One Single List of Words With Itself for Shared Associates

Option 2 compares each word on a list of single words with every other word on the list, and the output describes the relationships among words on the list. Optimally, list criteria would not only require that each cue relate only to its intended target, they would also require that each cue should not be related to another cue word on the list. Option 2 allows for an examination of the relationships among all of the cues or among all of the targets. The input text file would consist of just the list of cues or targets from Table 1. The output file is a semicolon-delimited text file that can be opened in Excel. Figure 3 shows sample output resulting from Option 2. The column headings and values are the same as those for Option 1. Each cue on the list is compared with every other cue. Although there are no direct associations among the cues, note that three cues are indirectly associated via shared associates (e.g., SOCKET and TIGER are indirectly associated via EYE). The last row of the output from Option 2 provides the sums of the count columns and the means of the value columns for each of the characteristics described, as well as a count of the words on the list that have not been normed.

A	B	C	D	E	F	G	H	I	J	K
Cues	Cue Set Size	Targets	Target Set Size	Forward Strength	#Q-T	Backward Strength	#T-Q	#Both	# Shared Associates	# Mediated Associates
TIGER	15									
WARRIOR	13									
JOKE	8									
THIMBLE	9									
CIRCLE	5									
FILM	12									
TAVERN	8									
SOCKET	13	TIGER	15	0		0			1	
MOB	10	WARRIOR	13	0		0			1	
REPTILE	8	TIGER	15	0		0			1	
Cues	Cue Set Size	Targets	Target Set Size	Forward Strength	#Q-T	Backward Strength	#T-Q	#Both	# Shared Associates	# Mediated Associates
10	33.6667	3	14.3333	0	0	0	0	0	3	0
# of 0 Assc	7									

L	M	N	O	P	Q	R	S	T	U	V
# Potentia	Shared A:	Mediator	Q-SA	SA-Q	T-SA	SA-T	Q-M	M-Q	T-M	M-T
0										
EYE			0.158	0	0.014	0				
FIGHT			0.024	0	0.083	0				
ANIMAL			0.014	0	0.028	0				
# Potentia	Shared As	Mediator	Q-SA	SA-Q	T-SA	SA-T	Q-M	M-Q	T-M	M-T
0			0.065333	0	0.041667	0	nan	nan	nan	nan

Figure 3. Sample output from Option 2. Note that SOCKET is compared with other cues from the cue input list (e.g., TIGER).

Options 3 and 4: Get Characteristics of Words

Option 4 takes, as input, a list of single words, and the output describes the characteristics of each word on the list. The output is a semicolon-delimited text file that can be opened in Excel. The characteristics of each word include the sample size, set size, frequency, concreteness, connectivity strength, mean connectivity, part of speech, and resonance (see Figure 4). The output also shows a count of words on the list that have not been normed. For Option 3, a single word can be entered at the command prompt, and the characteristics of that word are displayed on the screen.

Option 5: Get Cue/Response Relationships

Option 5 takes as input a list consisting of cue–target pairs; the pairs are listed in a text file, in capital letters, separated by a space (see the first column in Table 1). The output text file not only contains the characteristics of each word described in Options 3 and 4, but also displays the direct and indirect associative relationships between the cue (column A) and target (column J; see Figure 5). Therefore, not only are the sample size, set size, frequency, concreteness, connectivity strength, mean connectivity, part of speech, and resonance displayed for the cue (columns B–I) and for the target (columns K–R),

but the forward and backward association strengths are also displayed (columns S and T). Indirect associations, including the number of mediators and shared associates, are displayed in columns U and V, respectively. However, Option 5 does not present other information from Option 1, such as the number of associations between cues and other targets on the list: Only associates between the intended cue–target pair are listed in the Option 5 output. Option 5 provides paired associate information in a convenient table format, to facilitate computation of means in order to compare means across two lists, for instance.

Analysis of List Used in McRae and Boisvert (1998)

As previously mentioned, participants' knowledge about words can have an impact on experimental manipulations that are intended to be episodic to the experiment (Nelson et al., 2003; Nelson, McKinney, et al., 1998; Nelson et al., 1992). One such domain that depends on independence between the experimental manipulation and prior knowledge is that of semantic versus associative priming tasks. At issue is whether priming can be observed in the absence of association between the prime and the target (for reviews, see Hutchinson, 2003; Lucas, 2000; Neely, 1991). Many studies have reported semantic priming of unassociated

A	B	C	D	E	F	G	H	I
Cues	Sample Size	Cue Set Size	Cue Frequency	Cue Concreteness	Cue Connectivity Strength	Mean Cue Connectivity	Cue Part of Speech	Cue Resonance Probability
TIGER	143	15	7	6.07	3.17	1.13	0	0.2
WARRIOR	145	13	5	5.13	2.51	1.92	0	0.25
JOKE	165	8	22	3.48	2.06	1 N		0.57
THIMBLE	156	9	1	5.18	4.13	2.33	0	0
CIRCLE	156	5	60	5.14	1.84	1 N		1
FILM	138	12	96	5.91	4.08	2 N		0.55
TAVERN	147	8	2	6.18	3.29	1.5	0	0.13
SOCKET	139	13	3	5.9	3.48	1.62 N		0.31
MOB	127	10	10	5.1	2.58	2 N		0.4
REPTILE	148	8	0	6.65	1.58	1.5 N		0.63

not normed: 0

Figure 4. Sample output from Option 4, which provides characteristics of a list of words.

prime–target pairs (see Lucas, 2000, for a review). The purpose of the present experiment was to examine a list of presumably unassociated prime–target word pairs to determine whether—according to ListChecker Pro 1.2 and the USF word association norms—the word pairs were unassociated.

McRae and Boisvert (1998) was selected at random from among the studies cited in the Lucas (2000) review article for which the word lists were available. One stated goal of McRae and Boisvert was to demonstrate “the existence of automatic semantic similarity priming in the absence of normative association” (p. 558). They compared priming effects between a list of similar and dissimilar primes for 38 targets (Experiment 1): The targets were divided into two lists of 19 targets each. McRae and Boisvert conducted pilot studies, both to select targets that were not associatively related and to rule out both forward and backward prime–target associations. One pilot study

required college students to make judgments of association; another used a technique similar to that used to create the USF word association norms. Students were provided with a word and were asked to generate an associate.

METHOD

Materials

The sample word lists were taken from McRae and Boisvert (1998, Experiment 1) and are listed in Table 2. The comparison lists were their similar primes (SPs) and targets (Ts). Because the dissimilar primes are not relevant to our study, these lists were not included in the analyses. Separate text files were created for each list (1, 2) and each list type (SP, T), resulting in four input files: SP1, SP2, T1, and T2.

Procedure

Comparing words within each list. A comparison of words within each list is important because providing a prime that is as-

A	B	C	D	E	F	G	H	I
Cues	Cue Sample Size	Cue Set Size	Cue Frequency	Cue Concreteness	Cue Connectivity Strength	Mean Cue Connectivity	Cue Part of Speech	Cue Resonance Probability
TIGER	143	15	7	6.07	3.17	1.13 N		0.2
WARRIOR	145	13	5	5.13	2.51	1.92 N		0.25
JOKE	165	8	22	3.48	2.06	1 N		0.57
THIMBLE	156	9	1	5.18	4.13	2.33 N		0
CIRCLE	156	5	60	5.14	1.84	1 N		1
FILM	138	12	96	5.91	4.08	2 N		0.55
TAVERN	147	8	2	6.18	3.29	1.5 N		0.13
SOCKET	139	13	3	5.9	3.48	1.62 N		0.31
MOB	127	10	10	5.1	2.58	2 N		0.4
REPTILE	148	8	0	6.65	1.58	1.5 N		0.63

J	K	L	M	N	O	P	Q
Targets	Target Sample Size	Target Set Size	Target Frequency	Target Concreteness	Target Connectivity Strength	Mean Target Connectivity	Target Part of Speech
CAT	155	3	23	6.21	0.93	0 N	
SOLDIER	150	13	39	5.68	2.18	2 N	
LAUGH	165	8	28	4.29	1.95	1.75 V	
NEEDLE	165	8	15	5.79	2.17	2.12 N	
ROUND	127	7	81	4.34	1.98	0.43 AJ	
CAMERA	145	8	36	6.23	1.67	0.71 N	
PUB	139	6	1	6.05	2.83	3 N	
PLUG	144	25	23	6	3.67	1.3 N	
GANG	132	18	22	5.55	2.18	1.33 N	
LIZARD	149	21	1	5.67	4.13	2.17 N	

R	S	T	U	V
Target Resonance Probability	Forward Strength	Backward Strength	# Shared Associates	# Mediated Associates
1	0.154	0	1	4
0.42	0.186	0.033	5	2
0.88	0.612	0.055	1	3
0.88	0.218	0	5	4
0.57	0.199	0.197	1	3
0.71	0.116	0.166	2	2
0.33	0.259	0	3	2
0.3	0.173	0.111	4	3
0.22	0.15	0.015	3	3
0.22	0.27	0.154	4	2

Figure 5. Sample output from Option 5, which provides characteristics of a list of word pairs, including associative characteristics.

Table 2
Sample Word Lists (From McRae & Boisvert, 1998,
Experiment 1) Submitted to ListChecker Pro 1.2's
Options 1, 2, and 5

Cues (SP1)	Targets (T1)	Cue–Target Pairs (List 1)
PARAKEET*	BUDGIE*	PARAKEET–BUDGIE
FINCH*	CANARY	FINCH–CANARY
GOOSE	TURKEY	GOOSE–TURKEY
EAGLE	HAWK	EAGLE–HAWK
DUCK	CHICKEN	DUCK–CHICKEN
WHALE	DOLPHIN	WHALE–DOLPHIN
MOOSE	CARIBOU*	MOOSE–CARIBOU
PLUM	PRUNE	PLUM–PRUNE
COCONUT	PINEAPPLE*	COCONUT–PINEAPPLE
RADISH	BEETS	RADISH–BEETS
PUMPKIN	SQUASH	PUMPKIN–SQUASH
PEAS	BEANS	PEAS–BEANS
SLIPPERS	SANDALS	SLIPPERS–SANDALS
BRA	CAMISOLE*	BRA–CAMISOLE
TIE	BELT	TIE–BELT
LAMP	CHANDELIER*	LAMP–CHANDELIER
CLOSET	DRESSER	CLOSET–DRESSER
CUSHION	PILLOW	CUSHION–PILLOW
MAT	CARPET	MAT–CARPET
Cues (SP2)	Targets (T2)	Cue–Target Pairs (List 2)
MICROWAVE	TOASTER	MICROWAVE–TOASTER
BOTTLE	JAR	BOTTLE–JAR
CRAYON	PENCIL	CRAYON–PENCIL
HOE	SHOVEL	HOE–SHOVEL
FILE	SANDPAPER	FILE–SANDPAPER
SHED	BARN	SHED–BARN
YACHT	SHIP	YACHT–SHIP
CANOE	RAFT	CANOE–RAFT
BUS	SUBWAY	BUS–SUBWAY
WAGON	CART	WAGON–CART
TRUCK	VAN	TRUCK–VAN
JEEP	DUNEBUGGY*	JEEP–DUNEBUGGY
MOTORCYCLE	SCOOTER*	MOTORCYCLE–SCOOTER
AXE*	TOMAHAWK*	AXE–TOMAHAWK
MISSILE*	BOMB	MISSILE–BOMB
SLINGSHOT*	CATAPULT*	SLINGSHOT–CATAPULT
RIFLE	PISTOL	RIFLE–PISTOL
CANNON	BAZOOKA*	CANNON–BAZOOKA
SWORD	SPEAR	SWORD–SPEAR

*Nonnormed words.

sociated with another prime could interfere with priming effects on the intended target. Likewise, a target should not serve as a similar prime for another target. To determine whether primes and targets were associated with each other, each of the individual similar prime (SP1 and SP2) and target (T1 and T2) text files was submitted to Option 2 in ListChecker Pro 1.2 in order to determine whether items within a list could interfere with priming of the intended target.

Comparing prime lists with target lists. Each prime on the list should serve as a prime for only its intended target; a word should not be a potential similar prime for more than one target. To determine whether this constraint was achieved, each of the SP input files and their associated T files were submitted to Option 1 in ListChecker Pro 1.2, in order to determine three things: direct associations between the primes and their intended targets; direct associations between the primes and other, nonintended, targets; and indirect associations among the primes and targets. The reports generated from this option describe the specific prime–target relationships (however, see the Option 5 procedure, described next), but also generate the overall number of each of the three types of relationships listed. In addition, words that are implicated in indirect relationships are specified, as well as their association strength to each prime and target.

Determining associative relatedness for each prime–target pair. Each of the two text files that listed each prime–target pair for each list was submitted to Option 5 in ListChecker Pro 1.2. The goals were to determine whether direct relationships existed between intended prime–target pairs and the number and type of indirect relationships specific to each pair.

RESULTS

Comparing Words Within Each List

Each list (SP1, SP2, T1, and T2) was compared with itself by using Option 2. Among the similar primes and targets, there were four sets in which a prime or target was directly associated to another prime/target on its list. For instance, when SP1 was compared with itself, ListChecker Pro 1.2 revealed that DUCK and GOOSE had a forward association strength of .162 and a backward association strength of .261. In addition to direct associations, a number of indirect associations were revealed by the program: Across the four lists there were 122 shared associates, 40 mediators, and 15 potential nonnormed mediators (also known as *missing in action* [MIA] mediators). See Table 3 for a summary of direct and indirect associations for all comparisons.

Comparing Prime Lists With Target Lists

Each similar prime list (SP1, SP2) was compared with its intended target list (T1, T2) by using Option 1. Although, according to the operational definition for similar primes in the study, none of the primes were supposed to be associated with their intended targets (or presumably with any other target on the list), 21 intended prime–target pairs were directly associated. For example, CUSHION was a similar prime for PILLOW; the two had a forward association strength of .194 and a backward association strength of .03. In addition, four primes were directly associated with an unintended target. For instance, CANNON (whose intended target was BAZOOKA) was directly associated with SHIP (forward strength = .02) and with BOMB (forward strength = .03). The number of indirect associations was striking: There were 174 shared associations between primes and targets (81 on List 1, 93 on List 2), as well as 57 mediators and 12 MIA-potential nonnormed mediators (see Table 3). The numbers of associations may be higher—two primes and five targets had not been normed.

Determining Associative Relatedness for Each Prime–Target Pair

The Option 5 output specifies the direct forward and backward association strength for prime–target pairs, and sometimes identifies additional associations. This information could be calculated from the output from Option 1, but the Option 5 output organizes the association information divulged by ListChecker Pro 1.2 in a format that matches primes and their intended targets in a single row and also provides the word characteristics for each prime (cue) and target. Figure 6 shows the Option 5 output from the SP1 to T1 comparison. Note that associations between pairs can be quickly assessed. For instance, WHALE–DOLPHIN not only had a forward association strength of

Table 3
Summary of Direct and Indirect Association for All Comparisons

Comparison	Option	Direct Association			Indirect Association		
		Forward	Backward	Both	Shared	Mediated	MIA Med
SP1 × SP1	2	1	1		24	4	3
SP2 × SP2	2	1	1		54	24	8
T1 × T1	2	1	1		28	8	4
T2 × T2	2	0	0		16	4	
SP1 × T1	1	1	2	6	81	31	7
		1*					
	5	2	3	5	28	12	
SP2 × T2	1	4	2	6	93	26	5
		2*	2*				
	5	4	4	6	35	12	

*Direct association with unintended target.

.031 and a backward association strength of .05, it also shared five associates and had one mediating associate. (The output from Option 1 indicates that the shared associates are FISH, OCEAN, MAMMAL, WATER, and SAVE; the mediator is MAMMAL.)

Comparison of Dissimilar Prime and Target Lists

As a comparison, the lists of dissimilar primes were compared with themselves and with their intended targets. For the prime-to-prime comparison, only one prime

A	B	C	D	E	F	G	H	I
Cues	Cue Sample Size	Cue Set Size	Cue Frequency	Cue Concreteness	Cue Connectivity Strength	Mean Cue Connectivity	Cue Part of Speech	Cue Resonance Probability
DUCK	148	16	9	5.68	2.27	1.69	N	0.39
EAGLE	148	11	5	5.63	2.67	1.09	N	0.27
PARAKEET								
FINCH								
GOOSE	165	11	4	6.63	2.44	1.82	N	0.46
WHALE	97	17	0	6.23	2.96	1.73	N	0.4
MOOSE	165	18	0	6.03	4.96	2.17	N	0.22
PLUM	127	13	1	6.18	3.73	2.33	N	0.33
COCONUT								
RADISH	146	14	8	0	2.46	1.85	N	0.08
PUMPKIN	140	8	2	6.42	0.96	0.12	N	0.5
PEAS	148	13	24	0	0	0	N	0
SLIPPERS	119	8	7	5.74	2.92	0.88	N	0.13
BRA	140	15	0	6.25	0	0	N	0
TIE	148	17	23	5.55	2.19	1.14	V	0.64
LAMP	156	7	18	6.09	2.09	0.71	N	0.57
CLOSET	147	14	16	5.95	2.23	1.38	N	0.31
CUSHION	139	12	8	0	4.61	2.92	N	0.5
MAT	148	12	5	5.02	2.13	1	N	0.33

J	K	L	M	N	O	P	Q
Targets	Target Sample Size	Target Set Size	Target Frequency	Target Concreteness	Target Connectivity Strength	Mean Target Connectivity	Target Part of Speech
CHICKEN	184	29	37	5.79	4.83	1.8	N
HAWK	140	8	14	6.1	2.08	1.25	N
BUDGIE							
CANARY	130	4	0	5.56	1.7	1.5	N
TURKEY	149	14	9	6.63	3.8	2.23	N
DOLPHIN	139	18	1	0	4.12	2	N
CARIBOU							
PRUNE	94	14	1	6.26	2.68	1.55	N
PINEAPPLE							
BEETS							
SQUASH	154	20	2	0	2.99	2.19	N
BEANS	150	21	9	6	0	0	N
SANDALS	148	11	5	6.05	3.8	1.2	N
CAMISOLE							
BELT	127	11	29	5.98	1.48	1.27	N
CHANDELIER							
DRESSER	149	14	1	5.56	3.25	2.08	N
PILLOW	165	14	8	6.12	2.67	0.93	N
CARPET	145	17	13	5.68	3.55	1.56	N

R	S	T	U	V
Target Resonance Probability	Forward Strength	Backward Strength	# Shared Associates	# Mediated Associates
0.56	0.02	0	2	2
0.13	0	0.136	2	0
0.25				
0.39	0	0	3	2
0.38	0.031	0.05	5	1
0.27	0.039	0.053	3	0
0.44	0.014	0.052	1	0
0	0.081	0.027	4	0
0.1	0	0	2	1
0.46	0	0.024	0	0
0.15	0	0.013	2	1
0.57	0.194	0.03	2	3
0.5	0.014	0	2	2

Figure 6. Output from Option 5 comparing SP1–T1 prime–target pairs from McRae and Boisvert (1998).

had a direct forward and backward association (GOOSE–DUCK = .261 and .162, respectively), and only one prime had a backward association (TRUCK–JEEP = .025). There were 69 shared associates and 14 mediators revealed in the Option 2 comparisons and 107 shared associates and 26 mediators in the Option 1 comparison.

DISCUSSION

The importance of using normative data in creating word lists was demonstrated by the findings from the present experiment. Although McRae and Boisvert (1998) conducted some norming tasks to determine whether the semantically related words used in their studies were associated, the results demonstrate that their norms failed to reveal direct associations between prime–target pairs. However, even if there had been no direct associations between prime–target pairs, what McRae and Boisvert’s norming task failed to identify were the myriad indirect associations between the prime–target pairs. Not only were there both direct and indirect associations within the prime and target lists, hundreds of associates either were shared between the prime–target pairs or mediated them. The seemingly extreme number of indirect associates begs the question as to whether a list could ever be created for which there were no direct and/or indirect associates. As a comparison, the lists of dissimilar primes were compared with themselves and with their intended targets; the numbers of associations were notably smaller than for the similar primes and their targets. Therefore, the concept proposed by McRae and Boisvert—that semantic similarity and not normative association produces the priming effects they obtained—is not possible to discern, given the analysis of their word lists by ListChecker Pro 1.2. However, the lists of dissimilar primes were far from being free of indirect associations. This finding is not surprising, given that the dissimilar lists were created by trading List 1 and List 2 primes, or by re-pairing similar primes with different targets on the same list. Therefore, because the same primes and targets were present on the dissimilar as on the similar list, ListChecker Pro 1.2 identified those same associations in the analysis of the dissimilar list.

The goal of ListChecker Pro 1.2 is to identify these lurking associations to help the researcher create the most “clean” lists possible for their experimental purposes. The experience of the author has been that creating lists of completely unrelated (no direct associations) cues and targets (and among cues/targets and other words on their lists) is entirely possible. Although the author has not attempted a list with *no* indirect associations, she has regularly created lists that controlled for indirect associations between words—for instance, allowing no more than two shared associates or mediators between any given cue–target pair—and for allowing a difference of no greater than .5 between lists (e.g., List 1 vs. List 2; Eakin & Hertzog, 2006) or experimental conditions (e.g., control vs. interference; Eakin, 2005).

The purpose of the present article was to demonstrate that ListChecker Pro 1.2 can facilitate list construction in a variety of research areas. Although an example was used

from the associative versus semantic priming literature, the intention is not to enter that theoretical discussion. Rather, the intention was to demonstrate that the best-intentioned list construction can sometimes result in less than optimal materials. The best scenario is to have knowledge as complete as possible about the characteristics of words and the relationships among them, whether direct or indirect. Indeed, the indirect associations may have a greater impact on experimental outcomes such as memory and metamemory than do direct associations (D. L. Nelson, personal communication, January 16, 2010). Indirect associations are not determined by small restricted pre-experimental associative norming tasks; however, these associations have an impact on memory, metamemory, priming, visual word recognition, and other experimental outcomes. The USF word association norms provide information about both direct and indirect associations, and ListChecker Pro 1.2 is intended to be a helpful tool for checking created materials so that these characteristics are measured, controlled for, or manipulated.

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NOTES

1. The University of South Florida word association, rhyme, and word fragment norms (Nelson, McEvoy, & Schreiber, 1998, 2004) were developed to measure and catalogue both individual and associative characteristics of words. A complete description and the database are available elsewhere and are not reproduced in the present article.
2. For more details on calculating mediator and shared associate strength, see Nelson et al. (2004).

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