Difficulty and familiarity norms for 192 single-solution word fragments

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Normative data are presented for the probability of successfully completing 192 single-solution word fragments. Normative data on the familiarity of college students with the solution words are also given, along with estimates of word frequency from existing norms. Regression analyses were performed in order to predict fragment completion difficulty from familiarity, frequency, and several structural characteristics of the fragments. Familiarity, whether or not first and/or last letters appeared in the fragment, and the ratio of letters to missing letters in the fragment were included in the regression equation as significant predictors of difficulty for this fragment set.

In a fragment completion test, an experimental subject is presented with a number of word fragments (e.g., B__K) and is asked to fill in the missing letters to form a word. Such tests have been used as alternatives to traditional memory tests, such as recognition or recall, and are of some interest because quite often performance functions are different for fragment completion than they are for other tasks. For example, it has been shown that although performance of amnesic patients is much worse than that of normal subjects on recognition or recall, the performance of amnesics and normals is similar in fragment completion (e.g., Graf & Schacter, 1985; Graf, Squire, & Mandler, 1984; Jacoby & Witherspoon, 1982; Squire, Shimamura, & Graf, 1985; Warrington & Weiskrantz, 1970, 1974). For both kinds of subjects, prior exposure to words increases fragment completion performance for those words, but amnesic subjects do not recognize that they have been exposed previously to these words. Dissociations such as the one found between fragment completion and other memory tasks have aroused a good deal of theoretical and practical interest (e.g., Cohen, 1984; Squire, 1986; Tulving, 1983, 1985).

Most researchers who have used fragment completion as a task have used short common words and multiple-solution fragments, such as C__ or B__K. When the word *book* is presented as part of a study list, the probability that the fragment B__K will be completed as *book* increases. In other words, the most common dependent variable in fragment completion tasks has been the extent to which prior exposure biases the way in which a fragment is completed.

Tulving, Schacter, and Stark (1982) reported a dissociation involving fragment completion and recognition in normal subjects; recognition performance declined over a 1-week delay period, whereas fragment completion performance remained almost constant. Tulving et al. (1982)

used rather infrequent words and constructed the fragments so that only one word could be formed from each fragment. For example, one of their fragments was _R_U_IE_, from which one word can be formed (*crouper*). With fragments such as these, the dependent variable becomes the probability of solution, not the probability of a particular completion, and the task seems more like problem solving than word selection.

Previous research on the fragment completion task (e.g., Nelson, Canas, Bajo, & Keelean, in press; Nelson & McEvoy, 1984) has heavily stressed completion choice. One purpose of the present research was to supply normative information on the difficulty of one-solution fragments, since so little is known about performance on this task. The word fragments used by Tulving et al. (1982) were used because they are readily available, and it seems likely that researchers will be interested in using them.

Because the word list used by Tulving et al. (1982) contains many rather infrequent words, some of which may not even be known by many subjects, it also seemed useful to collect normative data on students' familiarity with these words. Familiarity ratings were obtained from students by asking them to rate each of the 192 words used by Tulving et al. (1982) on a 7-point familiarity scale. In addition, estimates of frequency of use of the words were obtained from the norms of Kučera and Francis (1967).

Fragment completion difficulty was estimated from the data of Erickson and Gaffney (1987) and from subjects whom we asked to complete word fragments as a filler task in experiments unrelated to fragment completion. Probability of successful completion of a fragment on the first exposure to it is the index of difficulty.

A secondary purpose of this research was to relate fragment completion difficulty to a variety of characteristics of the fragments and of the solution words. Regression analyses were performed to determine the extent to which completion difficulty could be predicted from the variables noted above along with several structural characteristics of the fragments.

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METHOD

Subjects

Subjects were students from the introductory psychology subject pool at the University of Texas at Arlington. These students volunteer for particular experiments to satisfy a course requirement, or they may choose to write summaries of published experiments if they do not wish to participate in experiments. A total of 80 subjects rated all 192 words for familiarity, and a number of other subjects provided difficulty data for various subsets of the word fragments.

Materials and Procedure

In order to obtain familiarity data, the 192 words used by Tulving et al. (1982) were randomly ordered and typed on four response sheets, with two columns of 25 words per page; 8 common words were added to the list to provide the same number of words per page and to add a number of words to the list as high-familiarity anchors. At the top of each page was a scale from 1 to 7, with 1 representing *low familiarity* and 7 *high familiarity*. Raters were instructed to judge each word for familiarity, which was described as "how commonly or frequently [the words] have been experienced or how familiar they appear to be." The word *person* was used as an example of a highly familiar word, and the word *amorphous* was used as an example of a relatively unfamiliar one. Raters were encouraged to use the entire 7-point scale, but were not instructed about how often any particular rating should be used.

Difficulty data came from Experiments 1, 2, and 3 of Erickson and Gaffney (1987) and from subjects in unrelated experiments who were asked to complete word fragments as a filler task. Difficulty was defined as the proportion of subjects who successfully completed a fragment with no prior exposure to the fragment or the word represented by the fragment within the experimental setting. Due to the vagaries of random assignment of words to conditions in the various experiments, difficulty for different fragments was estimated by different numbers of subjects, ranging from 96 to 180 subjects per fragment.¹

RESULTS

The basic data are presented in the Appendix, which gives each fragment, its solution word, the familiarity rating, the Kučera-Francis (1967) frequency, and the proportion of subjects who successfully completed the fragment.

We found that several of the items are not single-solution fragments as intended by Tulving et al. (1982); other solutions given by our subjects are noted, along with their probabilities. In some cases, the alternative solutions were more popular with our subjects than were the intended solutions (e.g., *glasses* and *classes* instead of *chassis* for __ASS_S).

Subjects were reasonably familiar with most of the words in the list; the mean and median familiarity rat-

ings were 5.19 and 5.78, respectively. However, the familiarity distribution is highly skewed, with a number of very unfamiliar words. For example, every one of the raters rated the word *mazurka* a 1, or very unfamiliar; *abattoir* and *Madeira* are other examples of very unfamiliar words. A glance at the frequencies shows that the words on the list are very infrequent in the language, with a modal frequency of 0 and a median of 1 in the Kučera-Francis norms (the mean frequency was 4.47).

The fragments were very difficult to complete; the mean and median probabilities of completing a fragment were .13 and .07, respectively. Twenty-three of the fragments were not completed correctly on first exposure by any of our subjects. The easiest fragment was TW__I__T, completed correctly by 84% of the subjects. The distribution of completion difficulty is highly skewed. The 15 fragments completed by more than 43% of the subjects all fall above the outlier criterion suggested by Tukey (1977) (i.e., more than 1.5 times the interquartile range above the third quartile of the distribution); there were no high-difficulty outliers.

It should be noted that probability of completion of these fragments by our subjects is considerably lower than that found by Tulving et al. (1982); the probability of completing a new fragment in their experiment was about .30. The difference in average fragment completion difficulty between our and Tulving et al.'s subject populations may simply reflect differences in subject populations or cultures, but it is large enough to be noteworthy.

We performed regression analyses to explore the extent to which frequency, familiarity, and several fragment structural variables could predict the probability with which a fragment was correctly completed. The structural variables selected are somewhat arbitrary, but they represent factors that seemed apt to be related to difficulty on a priori grounds. The following structural variables were calculated for each fragment:

- F1: length of the word to be completed.
- F2: 0 if neither the first nor last letter was present in the fragment, 1 if one of them was, 2 if both were present.
- F3: maximum number of successive blanks in the fragment.
- F4: maximum number of successive letters in the fragment.
- F5: ratio of letters to blanks in the fragment.
- F6: difference between number of letters and number of blanks in the fragment.

Table 1 shows the correlation matrix for these structural variables and the other variables discussed above. The variables that correlated significantly with fragment completion difficulty were familiarity, whether or not the first and/or last letters appeared in the fragment, and the ratio (or difference) between letters and blanks in the fragment. Since these latter two variables were so highly correlated, only F5 was included in the regression analyses.

Regression analyses were performed in order to predict

Table 1
Intercorrelations Among Several Fragment and Fragment-Word Characteristics, and Their Correlations with the Probability of Correctly Completing the Word Fragment

	<i>p</i> (corr.)	Familiarity	Frequency	F1	F2	F3	F4	F5
Familiarity	.381							
Frequency	.111	.256						
F1	-.153	.086	-.023					
F2	.331	-.016	.089	-.133				
F3	.027	.001	.002	.316	.375			
F4	-.056	-.088	-.006	-.070	-.325	-.089		
F5	.279	-.088	.102	-.511	.275	-.487	.258	
F6	.213	-.096	.096	-.445	.287	-.498	.258	.943

Note—See the text for definitions of F1 to F6. Correlations greater in absolute value than .16 are significant beyond the .05 level.

difficulty for the 192 fragments. First, a stepwise analysis was performed, and a regression equation was calculated for the variables suggested by the stepwise analysis. In this analysis, familiarity, F2, and F5, in that order, chosen as a result of the forward stepwise procedure, with a statistically significant multiple R^2 of .31. The resulting regression equation was:

$$p(\text{corr.}) = -.3028 + .0376 \text{ Familiarity} + .0663 \text{ F2} + .1400 \text{ F5}.$$

Although the difficulty of several fragments was not predicted well by this equation, there were no high-leverage outliers. In every case, the fragments not fit well by the equation (fragments with high Studentized residuals) were relatively easy, being completed by over 50% of the subjects.

DISCUSSION

The results of the regression analyses are not particularly surprising; for fragments that contain first and last letters, the word search process should be easier (e.g., Nelson et al., in press), and having fewer blanks in the fragment would rather obviously influence difficulty. Also, of course, if subjects are not familiar with a word, they are not apt to use it to complete a word fragment. At least some of the variables that did not enter into the equation above would be expected to be related to fragment completion for other word sets. For example, the ranges of frequency, word length, and maximum successive blanks are all rather restricted in this word fragment set.

The fragment completion difficulties and word familiarities reported here should be of use in future research by experimenters wishing to manipulate or control for difficulty or familiarity, or by those wishing to use them as covariates in data analysis.

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NOTE

1. Word fragments are extremely difficult to proofread. Because of proofreading errors, seven of the word fragments used here differed from those used by Tulving et al. (1982), and the sample sizes from which fragment difficulties were estimated were quite small ($n = 22$) for three fragments. These fragments are noted in the table of fragment difficulties in the Appendix.

APPENDIX
Familiarity Ratings, Normative Frequency, and Difficulty for
192 Single-Solution Word Fragments

Fragment	Word	Familiarity	Frequency	p(Completion)
_AR_VA__	aardvark	6.21	0	.09
	caravans (.11)			
A__T_IR	abattoir	1.05	0	0
AD____D*	adenoid	3.53	0	.01
	admired (.03)			
	adopted (.02)			
	advised (.02)			
	adhered (.01)			
AF__NI	afghani	2.90	0	0
_G_O_T_C	agnostic	3.90	0	.05
AI__P_CE	airspace	6.70	0	.14
AL____RY	allegory	3.72	3	.20
AL__N_C	almanac	6.50	1	.39
AN____UE	analogue	3.48	1	.01
AN__MY	anatomy	6.86	9	.55
_N__NNA	antenna	6.90	13	.10
A__IDO__	antidote	6.55	2	.02
AN__UE	antique	6.78	12	.04
AN__DY	anybody	7.00	42	.04
AP_O_B	aplomb	1.37	1	.15
APP____AL	approval	7.00	51	.28
	appeasal (.01)			
AP____OT	apricot	6.92	1	.53
AR____KE	archduke	5.15	0	.09
_SB__O_	asbestos	6.23	1	.03
A__A__IN	assassin	6.61	6	.02
AT__IT_	atrocitiy	4.53	0	.01
_V__AD_	avocado	6.95	11	.06
BA__E_OR	bachelor	7.00	6	.64
_A_D_NNA*	bandanna	6.95	0	.06
BA____CA	basilica	1.87	0	0
B_S_OO_	bassoon	5.53	0	.19
__YO_ET	bayonet	6.51	6	.04
B_Z_O__	bazooka	6.80	0	.26
__ES_X	beeswax	6.41	0	.02
_EG_NI_	begonia	4.56	0	.01
BE__VI_	behavior	6.95	96	.25
B__DDE_	bladder	6.78	0	.16
_L_RNE_	blarney	3.50	0	.03
_OG_Y__	bogeyman	5.76	0	0
_O__UGH	borough	4.62	5	.15
____SCH_	borscht	1.84	0	.01
	Porsche (.04)			
_OU__ON	bourbon	6.82	8	.03
	Houston (.02)			
_OYH_O_	boyhood	6.95	5	.23
BRA____N	brahmin	1.39	0	0
BR__A_O	bravado	3.83	7	.14
B__ZL_R	brazier	4.66	1	.27
B__CC__*	broccoli	6.92	1	.09
BU_L_K	bullock	2.14	2	.21
BU_E_U	bureau	6.66	43	.35
C__AR_T	cabaret	5.80	1	.11
	cigaret (.04)			
_A_H_RE	cashmere	6.13	2	0
C_VA__Y	cavalry	6.75	26	.36

APPENDIX (Continued)

Fragment	Word	Familiarity	Frequency	p(Completion)
__ASS__S	chassis	4.50	1	.02
	glasses (.22)			
	classes (.11)			
	grasses (.03)			
	brasses (.02)			
C__C_RY	chicory	2.49	0	.02
__IMN__Y	chimney	6.95	7	.51
CH____NK	chipmunk	6.88	0	.34
C__O__RA	cholera	4.93	1	.08
C__UTN__	chutney	1.80	1	.05
__I__AMO__	cinnamon	7.00	0	.01
__L__R__ET	clarinet	6.78	1	.21
__L__M__TE	climate	6.83	26	.07
C__BLE__	cobbler	6.48	0	.12
C____T__O	cockatoo	5.78	1	.02
__O__O__UT	coconut	6.98	7	.11
C__NIF__	conifer	2.42	0	.24
CO____AT	copycat	6.76	0	0
__O__V__TE	corvette	7.00	0	.34
__OS____K*†	cossack	3.05	3	0
__REV__CE	crevice	5.86	2	.54
CRO__U__	croquet	6.08	0	.15
__R__U__IE__	croupier	1.22	0	0
__UP__KE	cupcake	6.98	0	.22
CU____OR	curator	4.33	2	.10
C__TL__RY*	cutlery	5.13	0	.70
__YA__D__	cyanide	4.86	0	0
D__L__IU__	delirium	5.55	3	.06
__M__C__AT	democrat	6.86	13	.28
D__N__SA__	dinosaur	6.98	1	.38
__U__E__UM	duodenum	3.30	0	.02
__EC__R__N	electron	6.55	30	.12
__LL__P__E	ellipse	5.55	0	.11
E__S__AR__	emissary	3.24	2	.02
__PI__PH	epitaph	4.76	4	.18
__S__R__S__O	espresso	4.23	0	.01
__STU__R__	estuary	1.53	0	.02
__X__O__NT	exponent	6.45	0	.11
F__C__SM	fascism	5.63	3	.41
__LT__TE	filtrate	5.27	0	.01
__L__MI__G__	flamingo	6.78	0	.04
FL____EL	flannel	6.85	4	.45
G__GR__E	gangrene	6.60	0	.12
__AZ__L__E	gazelle	5.75	1	.16
__AZ__TE	gazette	6.28	10	.20
__I__Z__RD	gizzard	6.61	0	.18
G__DO__A	gondola	6.10	0	.24
G__A__RY	granary	2.45	2	.01
H__Y__FT	hayloft	6.86	0	.41
__EX__G__	hexagon	6.31	1	.27
__B__SC__S	hibiscus	4.60	0	.09
HO____ON	horizon	6.95	27	.03
	Houston (.26)			
__YA__N__H	hyacinth	3.63	0	.01
__YD__AN__	hydrant	6.78	0	.04
__DEO__O__	ideology	5.61	13	.16
IM__IB__	imbiber	1.42	0	.08
I__C____ON	incision	6.76	0	.01
__NE__T__A	inertia	5.08	2	.01
I__F____O	inferno	6.85	2	.18
IN__W__L__	inkwell	6.48	0	.06

APPENDIX (Continued)

Fragment	Word	Familiarity	Frequency	p(Completion)
_N__MN_A	insomnia	6.63	3	.08
__HM_S	isthmus	3.67	0	0
J_M___E	jamboree	6.20	0	.17
__TY_I_	katydid	3.70	0	0
K__O__NE	kerosene	6.76	6	.16
KN_P____	knapsack	6.60	0	.33
__MQ__T	kumquat	4.73	0	.27
__AC_OS__	lacrosse	4.63	0	.12
LA_Y__G	ladybug	7.00	0	.13
L_G__RD	laggard	1.28	0	.10
__NO_IN	lanolin	5.68	0	.07
__CT_RN	lectern	2.94	0	.12
_E__OSY	leprosy	5.78	1	.15
_E_TUC_	lettuce	7.00	0	.25
_EU__M_A	leukemia	6.80	3	.14
_EX_C_N†	lexicon	1.85	2	0
	Mexican (.18)			
L_NE__E	lineage	5.15	2	.04
__TH_UM	lithium	3.30	0	.17
_OZ__GE	lozenge	5.23	0	.07
__D_IRA	Madeira	1.18	1	.02
__JO_AM	marjoram	1.60	0	.01
__RT__I	martini	6.85	6	.07
M_S_A_A	mascara	6.73	1	.01
M_Z_R_A	mazurka	1.00	2	.01
__MB__NE	membrane	6.70	6	.16
M__T_OL	menthol	6.53	0	.25
_IGR__N_	migraine	6.75	0	.11
MO_O___M	monogram	6.75	0	.08
_YS__RY	mystery	6.92	39	.20
_EO__TE	neonate	1.24	0	0
_I_VA_A	nirvana	1.30	1	0
NO___NE	nocturne	3.07	3	.01
OB__I_K	obelisk	1.55	6	.03
O_T__US	octopus	6.90	1	.53
_P___TTA	operetta	4.32	6	.07
ORA__O_	oration	3.70	3	.07
_U_S___ER	outsider	6.88	3	0
	consumer (.01)			
___FF_N	paraffin	5.51	0	0
_A__NO_A	paranoia	6.20	0	.05
_E_D_L_M	pendulum	6.65	2	.09
_ER_X___*	peroxide	6.71	2	.02
	Xeroxing (.06)			
_E_UNI_	petunia	6.61	0	.01
PH___OH	pharaoh	6.26	0	.14
P__EN_X	phoenix	5.92	9	.68
P_GM__T	pigment	6.58	9	.79
P__E_TO	pimento	6.83	0	.15
__NK_ON	plankton	5.16	0	.19
PO__IW__	polliwog	4.23	0	.01
_U_R_ET	quartet	6.61	9	.02
R___B_W	rainbow	6.98	4	.74
__AR_EE	repartee	1.88	1	.01
_HE_OR__	rhetoric	4.75	5	.02
_H_MB_S	rhombus	3.87	0	.01
_HU___B	rhubarb	6.55	0	.06
RO___DA	rotunda	4.98	6	.10
_UFF_A_†	ruffian	4.80	2	0
_U__B_GA	rutabaga	5.18	1	.08
_A_SK_I_	Sanskrit	1.80	0	.02

APPENDIX (Continued)

Fragment	Word	Familiarity	Frequency	<i>p</i> (Completion)
_APP_I_	sapphire	6.86	0	.01
SC___AR	scimitar	1.39	1	.01
SE__O_A	sequoia	4.07	2	.05
_EX__NT	sextant	4.07	0	.13
S___FF	sheriff	7.00	20	.18
SI__C_N	silicon	5.63	2	.51
__RGHU_	sorghum	3.17	3	.01
_P_TU_A	spatula	6.73	0	.17
_PI_T_E	spittle	3.17	2	.03
	epistle (.01)			
_PR___ET	sprocket	5.78	0	.01
SU_G__N	surgeon	6.95	11	.62
S_AH__I	Swahili	3.80	1	.05
_AF__TA	taffeta	3.07	2	.10
T__UI_A	tequila	6.86	0	.10
_H_O_EM	theorem	5.28	18	.04
__YR_ID	thyroid	6.28	38	.07
_OB_GG__	toboggan	6.35	0	.09
_RI_Y__	tricycle	7.00	0	.01
TW__I__T	twilight	6.85	4	.84
_NI__R_E	universe	7.00	71	.02
_R__HR_	urethra	5.25	1	0
_E_D_TT_	vendetta	5.03	0	.02
V__A_D_H	verandah	4.50	1	.07
__R__UTH	vermouth	5.06	1	.02
__CAR__E*	vicarage	1.95	0	0
_IC_RO_	viceroi	4.87	1	.01
W_____NTY	warranty	6.92	0	.44
_AV__ET	wavelet	1.92	0	0
Y_O__NR_	yeomanry	1.37	0	0
_O_HUR_	yoghurt	6.48	0	0
Z___E_IN	zeppelin	5.03	0	.18

Note—Alternative solutions and their probabilities are shown for fragments that turned out to have more than one solution. *Fragments different from those used by Tulving et al. (1982). †Fragments for which the difficulty estimates are based on small sample sizes.

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