Supplementary Material

Table S1

Task 1: Stimuli for Translation English-German

Version 1					
Mixed list		Semantically organized list (Vehicles)		Abstract list	
Stimulus (Word)	Response example	Stimulus (Word)	Response example	Stimulus (Word)	Response example
mushroom	Pilz	car	Auto	sadness	Traurigkeit
cup	Tasse	tram	Straßenbahn	fun	Spaß
peace	Frieden	bicycle	Fahrrad	belief	Glaube
library	Bibliothek	submarine	U-Boot	joy	Freude
potato	Kartoffel	train	Zug	fear	Angst
trousers	Hose	truck	LKW	laziness	Faulheit
fridge	Kühlschrank	cable car	Seilbahn	superstition	Aberglaube
hospital	Krankenhaus	metro	U-Bahn	anger	Ärger
skirt	Rock	plane	Flugzeug	wish	Wunsch
pain	Schmerz	caravan	Wohnwagen	adventure	Abenteuer
Version 2					
Mixed list		Semantically organized list (Buildings)		Abstract list	
Stimulus (Word)	Response example	Stimulus (Word)	Stimulus (Word)	Response example	Stimulus (Word)
clock	Uhr	hospital	Krankenhaus	error	Fehler
ruler	Lineal	gym	Sporthalle	love	Liebe
raspberry	Himbeere	castle	Burg, Schloss	secret	Geheimnis
metro	U-Bahn	swimming pool	Schwimmhalle	hatred	Hass
carpet	Teppich	tower	Turm	curiosity	Neugierde
sadness	Traurigkeit	library	Bibliothek	thought	Gedanke
blackberry	Brombeere	church	Kirche	exhaustion	Erschöpfung
tape	Klebeband	airport	Flughafen	hazard	Zufall, Gefahr
feeling	Gefühl	cinema	Kino	discovery	Entdeckung
tram	Straßenbahn	shop	Geschäft, Laden	peace	Frieden

Table S2

Task 2: Stimuli for Translation German-English

Version 1					
Mixed list		Semantically organized list (Fruits)		Abstract list	
Stimulus (Word)	Response example	Stimulus (Word)	Response example	Stimulus (Word)	Response example
Gurke	cucumber	Kirsche	cherry	Stolz	pride
Meinung	opinion	Himbeere	raspberry	Erinnerung	memory
Teller	plate	Zitrone	lemon	Schwäche	weakness
Handschuhe	gloves	Erdbeere	strawberry	Glück	luck
Schwimmhalle	swimming pool	Ananas	pineapple	Ehre	honour
Kürbis	pumpkin	Weintraube	grape	Feind	enemy
Messer	knife	Pflaume	plum	Hilfsbereit-schaft	helpfulness
Kleid	dress	Erdnuss	peanut	Mut	courage
Geheimnis	secret	Pfirsich	peach	Enttäuschung	disappoint-ment
Kino	cinema	Brombeere	blackberry	Gefühl	feeling
Version 2					
Mixed list		Semantically organized list (Vegetables)		Abstract list	
Stimulus (Word)	Response example	Stimulus (Word)	Response example	Stimulus (Word)	Response example
Kirsche	cherry	Gurke	cucumber	Schmerz	pain
Auto	car	Blumenkohl	cauliflower	Hoffnung	hope
Papierkorb	bin	Knoblauch	garlic	Wissen	knowledge
Erinnerung	memory	Bohne	bean	Zweifel	doubt
Kleber	glue	Mais	corn	Vertrauen	trust
Wunsch	wish	Kartoffel	potato	Müdigkeit	tiredness
Zug	train	Zwiebel	onion	Verlust	loss
Tisch	table	Ingwer	ginger	Geburtstag	birthday
Pflaume	plum	Kürbis	pumpkin	Schuld	guilt, fault
Fenster	window	Pilz	mushroom	Meinung	opinion

Table S3

Task 3: Stimuli for Picture Naming in German

Version 1			
Mixed list		Semantically organized list (Furniture)	
Stimulus (Picture)	Response example	Stimulus (Picture)	Response example
corn	Mais	window	Fenster
freezer	Gefriertruhe	shelf	Regal
church	Kirche	chair	Stuhl
kettle	Wasserkocher	table	Tisch
beans	Bohnen	clock	Uhr
suit	Anzug	wardrobe	Kleiderschrank
tower	Turm	door	Tür
cap	Mütze	bath tub	Badewanne
stove	Herd	carpet	Teppich
bra	BH	sink	Waschbecken
Version 2			
Mixed list		Semantically organized list (Kitchenware)	
Stimulus (Picture)	Response example	Stimulus (Picture)	Response example
shelf	Regal	fridge	Kühlschrank
file	Ordner, Ringhefter	knife	Messer
pineapple	Ananas	cup	Tasse
pencil case	Federmappe, Federtasche	stove	Herd
door	Tür	fork	Gabel
peanut	Erdnuss	freezer	Gefriertruhe
caravan	Wohnmobil	pot	Topf
lemon	Zitrone	spoon	Löffel
pencil	Bleistift	kettle	Wasserkocher
truck	LKW	plate	Teller

Table S4

Task 4: Stimuli for Picture Naming in English

Version 1			
Mixed list		Semantically organized list (Stationery)	
Stimulus (Picture)	Response example	Stimulus (Picture)	Response example
pot	pot	ruler	ruler
boots	boots	pen	pen
garlic	garlic	glue	glue
airport	airport	tape	tape
coat	coat	scissors	scissors
fork	fork	rubber	rubber, eraser
onion	onion	pencil	pencil
scarf	scarf	folder	folder
spoon	spoon	bin	bin
castle	castle	pencil case	pencil case
Version 2			
Mixed list		Semantically organized list (Clothing)	
Stimulus (Picture)	Response example	Stimulus (Picture)	Response example
strawberry	strawberry	trousers	trousers, pants
bicycle	bicycle	dress	dress
wardrobe	wardrobe	boots	boots
scissors	scissors	gloves	gloves
plane	plane	coat	coat
chair	chair	hat	hat, cap
peach	peach	suit	suit
rubber	rubber, eraser	bra	bra
grapes	grapes	skirt	skirt
pen	pen	scarf	scarf

Table S5

Experiment 1: Planned comparisons on estimated marginal means.

Task and dependent variable	Target Language	Planned Comparison List type	Estimate	SE	df	t value	p
Translation Accuracy	German	Mixed vs. semantic	-0.555	0.615		0.902	.367
		Mixed vs. abstract	-0.117	0.603		-0.193	.847
		Semantic vs. abstract	-0.672	0.616		-1.091	.275
	English	Mixed vs. semantic	-1.443	0.582		-2.479	.013*
		Mixed vs. abstract	-0.754	0.583		-1.293	.196
		Semantic vs. abstract	0.689	0.575		1.198	.231
Translation Response Times	German	Mixed vs. semantic	-87.7	108	123	-0.815	.417
		Mixed vs. abstract	-152.9	107	123	-1.424	.157
		Semantic vs. abstract	-65.3	108	123	-0.607	.545
	English	Mixed vs. semantic	257.40	109	128	2.366	.020*
		Mixed vs. abstract	252.58	107	125	2.352	.020*
		Semantic vs. abstract	-4.83	109	131	-0.044	.965
Picture Naming Accuracy	German	Mixed vs. semantic	0.036	0.642		0.057	.955
	English	Mixed vs. semantic	-0.372	.332		-1.121	.262
Picture Naming Response Times	German	Mixed vs. semantic	-160.0	68.6	77.4	-2.333	.022*
	English	Mixed vs. semantic	71.2	71.2	88.4	1.001	.320

Note: Degrees of freedom for response time data use the Kenward-Roger method; for accuracies (provided as log odds ratios), no indication of degrees of freedom is available. * $p < .05$

Table S6

Experiment 2: Planned comparisons on estimated marginal means.

Task and dependent variable	Target Language	Planned Comparison List type	Estimate	*SE*	df	*t* value	*p*
Translation Accuracy	German	Mixed vs. semantic	0.209	0.632		0.331	.741
		Mixed vs. abstract	-0.409	0.621		-0.658	.510
		Semantic vs. abstract	-0.618	0.625		-0.989	.323
	English	Mixed vs. semantic	-1.175	0.616		-1.908	.056 °
		Mixed vs. abstract	-0.307	0.616		-0.498	.619
		Semantic vs. abstract	0.868	0.609		1.426	.154
Translation Response Times	German	Mixed vs. semantic	-55.90	100.0	111	-0.559	.577
		Mixed vs. abstract	-46.07	100.0	111	-0.461	.646
		Semantic vs. abstract	9.83	99.5	111	0.099	.922
	English	Mixed vs. semantic	122	103.1	125	1.187	.238
		Mixed vs. abstract	178	98.9	115	1.804	.074 °
		Semantic vs. abstract	56	102.8	128	0.545	.587
Picture Naming Accuracy	German	Mixed vs. semantic	0.227	0.388		0.586	.558
	English	Mixed vs. semantic	-0.212	0.386		-0.550	.582
Picture Naming Response Times	German	Mixed vs. semantic	-63.7	88.3	76.7	-0.722	.473
	English	Mixed vs. semantic	-17.8	90.1	81.3	-0.198	.843

Note: Degrees of freedom for response time data use the Kenward-Roger method; for accuracies (provided as log odds ratios), no indication of degrees of freedom is available. ° $p < .10$

Section S7: Additional results and discussion of recall performance (Experiment 1)

The average overall recall rate was 36 out of 100 presented stimuli ($SD = 10.35$, range: 13 – 62). Interestingly, 15 % of the recalled items were stimuli to which participants had provided no response in the original naming tasks. More items were noted in German (i.e. in L1; $M = 20.39$, $SD = 7.61$) than in English (L2; $M = 15.36$, $SD = 8.78$; $t(43) = -2.632$, $p = .012$). For stimuli originally presented as words, more were recalled in the originally presented language ($M = 10.98$, $SD = 5.51$) than in the language of the required response ($M = 5.18$, $SD = 5.51$; $t(43) = 7.082$, p < .001). However, for picture naming, more stimuli were recalled in the language of the spoken response ($M = 13.34$, $SD = 5.37$) than in the other language ($M = 6.25$, $SD = 3.97$; $t(43) = 5.876$, $p < .001$), irrespective of its status as L1 or L2. Overall, there was an advantage for stimuli that had been presented as pictures ($M = 19.59$, $SD = 5.00$) compared to stimuli presented as words ($M = 16.16$, $SD = 6.89$; $t(43) = -3.853$, $p < .001$).

Interestingly, participants tended to recall more stimuli from the picture naming tasks than from the word translation tasks. This picture superiority effect can be explained by dual-coding-theory (Paivio et al., 1988), according to which two independent mental processes are involved in picture naming: viewing the image visually but naming the answer verbally. Consequently, pictures are encoded both visually and verbally, whereas verbal tasks, such as translation, typically result in only one form of encoding. This could facilitate the storage and recall of pictures relative to words.

Furthermore, we observed a weaker overall recall performance for abstract stimuli. This could be due to the so-called concreteness effect, which suggests easier recall for concrete than abstract stimuli. Again, dual-coding theory (Paivio et al., 1988) can provide an explanation here, with the idea that if there is no available image the stimulus can only be encoded unimodally. Furthermore, word meaning is highly context-dependent, which makes processing in context-free presentation particularly difficult (Kroll & Tokowicz, 2005), especially for abstract stimuli which were not presented in semantically organized lists.

Finally, participants were asked to write down the items they recalled in whichever language first came to mind. More items from the translation task were recalled in the originally presented language than in the language of the required response. This can perhaps be explained by the fact that the presented item was visible on the screen for an extended period of time, potentially leading to deeper processing than the auditory presence of the spoken response, which lasted just a few hundred milliseconds. The reverse pattern was found for picture naming: Here, the recalled language in most cases was the language of the spoken response. This makes sense in view of the fact that the only verbal component in this task was the verbal response produced by the participant. Occasionally, items from picture naming in L2 were recalled in L1. In these cases, participants may have used their native language to gain access to word meaning and recall. This was especially likely to be the case if the L2 word had not been available, but the picture was still remembered: 15 % of such responses were stimuli to which the participant had not responded in the original naming task. It can be assumed that these stimuli remained especially salient in the participants' mind, since most of them seemed very motivated and expressed curiosity about unfamiliar vocabulary after completing the experiment.

Most importantly however, as explained in the main text, a category effect in terms of category facilitation was also found for the recall task. Again, this effect was strongest for stimuli which were originally translated from L1 to L2.

References

Kroll, J. F., & Tokowicz, N. (2005). Models of bilingual representation and processing. *Handbook of Bilingualism: Psycholinguistic Approaches*, 531–553.

Paivio, A., Clark, J. M., & Lambert, W. E. (1988). Bilingual dual-coding theory and semantic repetition effects on recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *14*(1), 163.