

Supplementary Material A

In Catalonia, Catalan and Spanish are both official languages and education in the two languages is offered to children beginning at the kindergarten level. The current education system requires that at the end of primary school, children are able to read, write, speak, and understand both Catalan and Spanish. In high school, some classes are taught in Catalan and others in Spanish. At the university level, classes and exams can be in either language – sometimes half of the test is in Catalan and the other half in Spanish. Radio and television programs broadcast in Catalan and Spanish. Furthermore, newspapers contain articles written in the two languages. All bilingual participants in the current study passed the Catalan–Spanish language proficiency exam that is required for enrollment at the university. In order to pass this exam students must be highly proficient in all aspects of the two languages (vocabulary, grammar, etc.). A particular characteristic of Spanish-Catalan bilinguals is that they speak two Romance languages that share many important properties. Approximately 70% of the vocabulary can be considered to have similar sounding translations. Additionally, grammar and syntax relate closely across the two languages. Still, significant differences are found between Catalan and Spanish in their phonological repertoires. Spanish has fewer vowels than Catalan and some consonants exist only in Spanish, while others are specific to Catalan. Therefore, these two languages provide an ideal model for examining the role of phonological processes in language production of bilinguals.

Supplementary Material B

Excerpt of the socioeconomic questionnaire:

1. Please specify the maximum studies that you have completed.
2. Please specify your current occupation.
3. Please specify the maximum studies that your father has completed.
4. Please specify the maximum studies that your mother has completed.
5. Please indicate if your family receives some kind of financial support.
6. Please indicate how many places of residence your family possesses.
7. Please indicate whether you have lived most of your lifetime in a rural or urban environment.
8. Please indicate whether your current place of residence is rented or owned.
9. Please indicate the average monthly income of your family and how many members of the family are currently working?
10. Please indicate with how many people you live at your current place of residence.
11. Please indicate what kind of amenities and services your current place of residence includes.

Supplementary Material C

Preliminary steps of variable exploration:

First, we reduced the number of variables to be used as predictors on the basis of their importance towards predicting naming latencies. For this purpose, we ran random forest analyses (e.g., Breiman, 2001; Tagliamonte & Baayen, 2012) using the package “party” in R and the function “cforest” (Hothorn, Bühlmann, Dudoit, Molinaro, & Van Der Laan, 2006; Strobl, Boulesteix, Zeileis, & Hothorn, 2007; Strobl, Boulesteix, Kneib, Augustin, & Zeileis, 2008). A random forest is a collection of classification trees providing a single measure of importance for each predictor. Regarding phonological similarity across languages, the random forest analysis clearly rated the ALINE measure as being of higher importance in predicting bilingual naming latencies than the Levenshtein distance measure. Thus for all of our analyses we chose the ALINE measure as the only measure for translation similarity. The measure of phonological neighbors in the unspoken language was rated as least important toward predicting naming latencies.¹ We also ran a hierarchical clustering analysis to assess the correlations among the predictor variables (using the “Hmisc” package in R and the “varclus” function; Harrell et al., 2010). Fig. 2 in Supplementary Material C reports the inter-correlations of the selected item-related variables that were entered in the analysis. Since the main focus of our approach was to explore differences in the influences of item-related variables depending on the speaker group (mono- vs. bilingual), all continuous predictor variables were involved in interaction terms with the factor speaker group. Thus, all item-

¹In addition, we ran several linear mixed effect models testing for the influence of phonological neighborhood in the unspoken language in the bilingual naming latencies. Results showed no influence of this predictor on bilingual naming latencies. We will further discuss this null result in the Discussion section.

related predictors, except lexical frequency and translation similarity, were centered (see below for the reference levels of the variables of interest lexical frequency and translation similarity).² Centering the variables facilitates interpretation of the parameter estimates since the predictor mean is set to zero. Finally, due to collinearity between phonological neighborhood density (PhND) and phoneme word length, the latter was orthogonalized on the former by running a linear model in which phoneme word length was predicted by PhND.³ The residuals of this linear model were entered as fixed effect in the linear mixed-effects model. We also checked that the residualized phoneme word length variable was highly correlated with the original one ($\rho = 0.79$). As an additional check, we also report variance inflation factors (VIF) of each of the predictors in the models to ensure reliability of the analyses. VIF indicates how much the variance of an estimated coefficient is increased due to collinearity in the regression model.⁴

Fig. 2 in Supplementary Material C: Hierarchical clustering analysis using Spearman's ρ^2 of the item-related variables included in the analysis (TrSim = translation similarity; PhonLength = residualized phoneme word length; PhND = phonological neighborhood; LexFreq = lexical frequency; AoA = age of acquisition; Nagr = correct target name agreement).

² Results remained unchanged when the un-centered original variables were entered in the analysis (see Belsley, 1984; Dalal & Zickar, 2012).

³ Given the recent work by Wurm & FisiCaro (2014), it is important to note that our results did not change when phoneme word length was entered as unresidualized predictor.

⁴ VIF values around 2 are considered as problematic for regression coefficients of linear fixed effects that are not involved in interactions.

Supplementary Material D

Model construction during data exploration:

Models always included the main factor speaker group (monolinguals vs. L1 speaker vs. L2 speaker) to test for the presence of a bilingual naming cost, and variables accounting for general fatigue and/or training effects in the naming latencies by coding for trial order presentation (from 1 to 533) and session (first or second; e.g., for general fatigue effects in large picture naming studies see Snodgrass & Yuditsky, 1996, Székely et al., 2003). Then, predictors motivated by previous naming studies on monolingual naming performance (name agreement, age of acquisition [AoA], PhND, first syllable frequency, phoneme length), and participant-related variables like socio-economic status, vocabulary size, executive control measure, and button-press speed were included in the model. Of greatest importance were the variables expected to explain the bilingual cost, namely lexical frequency and translation similarity. First, as would be predicted by the weaker links hypothesis, we entered lexical frequency. This variable was referenced at the highest frequency value (i.e., not centered). Second, as suggested by the post-lexical account, we entered translation similarity, also referenced at the highest translation similarity values. For the final model, we introduced by-participant random intercepts, by-participant random slopes for lexical frequency and translation similarity, by-item random intercepts, and by-item random slopes for speaker group. Equation 1 in Supplementary Material D describes the fixed structure of the final

model in which naming latencies were predicted as a linear function of intercept (b_0), the control variables (c_{1-3} ; i.e., participant-related variables, trial order, and session), the item-related variables (d_{4-8}), the speaker group factor (e_{9-10}), and all interactions of the group factor with the item-related variables (f_{11-20}).

Equation 1 in Supplementary Material D: Structure of the model tested in the present analyses

RT = b_0 +

$$\begin{aligned}
 & c_1 \text{ Trial order} \begin{bmatrix} 533 \\ \vdots \\ 268 \\ \vdots \\ 1 \end{bmatrix} + c_2 \text{ Session} \begin{bmatrix} 2 \\ 1 \end{bmatrix} + c_3 \text{ Button-press speed} \begin{bmatrix} 539 \\ \vdots \\ 408 \\ \vdots \\ 327 \end{bmatrix} + \\
 & d_4 \text{ NameAgr} \begin{bmatrix} 0.8 \\ \vdots \\ 0 \\ \vdots \\ -4.8 \end{bmatrix} + d_5 \text{ AoA} \begin{bmatrix} 3.2 \\ \vdots \\ 0 \\ \vdots \\ -2.3 \end{bmatrix} + d_6 \text{ PhND} \begin{bmatrix} 4.6 \\ \vdots \\ 0 \\ \vdots \\ -0.7 \end{bmatrix} + \\
 & d_7 \text{ Freq} \begin{bmatrix} 2.7 \\ \vdots \\ 1.8 \\ \vdots \\ 0 \end{bmatrix} + d_8 \text{ TrSim} \begin{bmatrix} 0.9 \\ \vdots \\ 0.3 \\ \vdots \\ 0 \end{bmatrix} + \\
 & e_9 \text{ Group} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} + e_{10} \text{ Group} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} + \\
 & f_{11} \text{ Group} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} * \text{NameAgr} \begin{bmatrix} 0.8 \\ \vdots \\ 0 \\ \vdots \\ -4.8 \end{bmatrix} + f_{12} \text{ Group} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} * \text{NameAgr} \begin{bmatrix} 0.8 \\ \vdots \\ 0 \\ \vdots \\ -4.8 \end{bmatrix} + \\
 & f_{11} \text{ Group} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} * \text{AoA} \begin{bmatrix} 3.2 \\ \vdots \\ 0 \\ \vdots \\ -2.3 \end{bmatrix} + f_{12} \text{ Group} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} * \text{AoA} \begin{bmatrix} 3.2 \\ \vdots \\ 0 \\ \vdots \\ -2.3 \end{bmatrix} + \\
 & f_{19} \text{ Group} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} * \text{TrSim} \begin{bmatrix} 0.9 \\ \vdots \\ 0.3 \\ \vdots \\ 0 \end{bmatrix} + f_{20} \text{ Group} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} * \text{TrSim} \begin{bmatrix} 0.9 \\ \vdots \\ 0.3 \\ \vdots \\ 0 \end{bmatrix}
 \end{aligned}$$

Note: The linear mixed model included control variables, the relevant item-related predictors, the factor speaker group, and the interactions between the item-related predictors and speaker group as fixed effects. The bilingual cost was estimated using centered predictors except for

the predictors of interest, namely lexical frequency and translation similarity that were entered with maximal values in model 3 and 4 respectively. Freq = lexical frequency; TrSim= translation similarity; NameAgr = correct target name agreement; AoA = age-of-acquisition; PhND = phonological neighborhood density.

Supplementary Material E

Spanish	Catalan	Spanish	Catalan	Spanish	Catalan
abanico	ventall	Barba	barba	cafetera	cafetera
abeja	abella	Barbacoa	barbacoa	caja	caixa
acordeón	acordió	Barco	vaixell	cajón	calaix
agenda	agenda	Barril	barril	calabaza	carbassa
aguja	agulla	Bastón	bastó	calcetín	mitjó
ajedrez	escacs	Batería	bateria	calculadora	calculadora
ajo	all	Baúl	bagul	calendario	calendari
ala	ala	Bebé	nadó	cámara	càmera
alcachofa	carxofa	Bellota	aglà	camarero	cambrer
alcantarilla	claveguera	Berenjena	albergínia	camello	camell
aleta	aleta	Biberón	biberó	camión	camió
alfombra	catifa	Bicicleta	bicicleta	camisa	camisa
almohada	coixí	Bigote	bigoti	camiseta	samarreta
almohadilla	coixinet	Bisagra	frontissa	campana	campana
altavoz	altaveu	Boca	boca	candado	cademat
ambulancia	ambulància	Bocadillo	entrepà	candelabro	canelobre
ancla	àncora	Bola	bola	cangrejo	cranc
anillo	anell	Bolígrafo	bolígraf	canguro	cangur
antena	antena	Bolo	bitlla	cañón	canó
anzuelo	ham	Bolsa	bossa	capucha	caputxa
araña	aranya	Bolsillo	butxaca	cara	cara
árbol	arbre	Bolso	bossa	caracol	cargol
archivador	arxivador	Bomba	bomba	caracola	cargol de mar
arco	arc	Bombero	bomber	caramelo	caramel
ardilla	esquirol	Bombilla	bombeta	caravana	caravana
armario	armari	Bota	bota	carpeta	carpeta
arpa	arpa	Bote	pot	carretera	carretera
ascensor	ascensor	Botella	ampolla	carretilla	carretó
aspiradora	aspiradora	Botón	botó	carro	carro
astronauta	astronauta	Bragas	calcetes	cartera	cartera
autobús	autobús	Brazo	braç	casa	casa
avestruz	estruç	bruja	bruixa	casco	casac
avión	avió	bufanda	bufanda	castañuelas	castanyoles
bailarina	ballarina	búho	mussol	castillo	castell

bala	bala	bumerán	bumerang	catapulta	catapulta
balanza	balança	burro	ruc	cazo	cassó
balcón	balcó	buzón	bústia	cebolla	ceba
ballena	balena	caballero	cavaller	cebra	zebra
banco	banc	caballo	cavall	ceja	cella
bandeja	safata	cabra	cabra	cenicero	cendrer
bandera	bandera	cacahuete	cacauet	cepillo	raspall
bañador	banyador	cactus	cactus	cerdo	porc
bañera	banyera	cadena	cadena	cerebro	cervell
cereza	cirera	cubo	galleda	fantasma	fantasma
Spanish	Catalan	Spanish	Catalan	Spanish	Catalan
cerilla	misto	cuchara	cullera	faro	far
cerrojo	balda	cuchillo	ganivet	farola	fanal
cesta	cistella	cuello	coll	flauta	flauta
chaleco	armilla	cuerna	corda	flecha	fletxa
chichón	bony	cuerno	banya	flor	flor
chimenea	xemeneia	culo	cul	foca	foca
chupete	xumet	cuna	bressol	foco	focus
cicatriz	cicatriu	cura	capellà	fregona	fregona
ciervo	cérvol	dado	dau	fresa	maduixa
cigarro	cigarret	dedal	didal	fuego	foc
cinturón	cinturó	dedo	dit	fuelle	font
circo	circ	delfín	dofí	futbolín	futbolí
círculo	cercle	dentadura	dentadura	gafas	ulleres
cisne	cigne	dentista	dentista	gallina	gallina
ciudad	ciutat	desierto	desert	gancho	ganxo
clip	clip	diamante	diamant	gato	gat
coche	cotxe	diana	diana	genio	geni
cocina	cuina	dinero	diners	girasol	gira-sol
cocodrilo	cocodril	dinosaurio	dinosaure	globo	globus
codo	colze	disco	disc	gorila	goril·la
cohetes	coet	dominó	dòmino	gorro	gorra
colador	colador	dragón	drac	gota	gota
colchón	matalàs	ducha	dutxa	granada	granada
collar	collaret	elefante	elefant	grifo	aixeta
columna	columna	embudo	embut	guante	guant
columpio	gronxador	enchufe	endoll	guisante	pèsol
comba	corda	enfermera	infermera	guitarra	guitarra
cometa	estel	erizo	eriçó	gusano	cuc
cómoda	calaixera	escalera	escala	hacha	destral
conejo	conill	escoba	escombra	hada	fada
copa	copa	escorpión	escorpí	hamaca	hamaca
copo	floc	escritorio	escriptori	hamburguesa	hamburguesa
corazón	cor	espada	espasa	helado	gelat
corbata	corbata	espalda	esquena	helicóptero	helicòpter
corcho	suro	espárrago	espàrrec	hiena	hiena

corona	corona	espejo	mirall	hilo	fil
cortacésped	tallagespa	esposas	manilles	hipopótamo	hipopòtam
cortina	cortina	esqueleto	esquelet	hoja	fulla
cremallera	cremallera	esquimal	esquimal	hombro	espatlla
cresta	cresta	esquí	esquí	hormiga	formiga
cronómetro	cronòmetre	estatua	estàtua	hoz	falç
cruz	creu	estrella	estel	hucha	guardiola
cuadrado	quadrat	fábrica	fàbrica	huella	empremta
cuadro	quadre	falda	faldilla	hueso	os
huevo	ou	maleta	maleta	nevera	nevera
Spanish	Catalan	Spanish	Catalan	Spanish	Catalan

humo	fum	mancha	taca	niña	nena
iglesia	església	manguera	mànega	niño	nen
iglú	iglú	mano	mà	nota	nota
imán	imant	manzana	poma	novia	núvia
imperdible	imperdible	mapa	mapa	nube	núvol
impresora	impressora	mapache	ós rentador	nudo	nus
indio	indi	mar	mar	nuez	nou
interruptor	interruptor	marco	marc	ojo	ull
isla	illa	marinero	mariner	olla	olla
jabalí	porc senglar	mariposa	papallona	ordenador	ordinador
jamón	pernil	mariquita	marieta	oreja	orella
jarra	gerra	martillo	martell	oso	ós
jarrón	gerro	mecedora	balancí	oveja	ovella
jaula	gàbia	mechero	encenedor	paja	palla
jeringuilla	xeringa	medalla	medalla	pájaro	ocell
jersey	jersei	media	mitja	pala	pala
jirafa	girafa	melocotón	préssec	palmera	palmera
kiwi	kiwi	melón	meló	paloma	colom
laberinto	laberint	mesa	taula	palomita	crispeta
labio	llavi	metro	metre	pan	pa
ladrillo	maó	micrófono	micròfon	pantalón	pantaló
lágrima	llàgrima	microondas	microones	pañal	bolquer
lámpara	llum	microscopio	microscopi	paquete	paquet
langosta	llagosta	mochila	motxilla	paraguas	paraigües
lápiz	llapis	mofeta	mofeta	parchís	parxís
lata	llauna	molino	molí	pastilla	pastilla
látigo	fuet	momia	mòmia	patata	patata
lavabo	lavabo	moneda	moneda	patín	patí
lavadora	rentadora	monja	monja	pato	ànec
lazo	llaç	mono	mico	payaso	pallasso
lechuga	enciam	monopatín	monopatí	pecera	peixera
lengua	llengua	montaña	muntanya	pecho	pit
león	lleó	mosca	mosca	peine	pinta
libélula	libèl·lula	mosquito	mosquit	pelota	pilota

libro	llibre	moto	moto	peluca	perruca
lima	llima	muela	queixal	pendiente	arracada
lince	linx	mujer	dona	peonza	baldufa
linterna	llanterna	muleta	crossa	pera	pera
llave	clau	muñeca	nina	percha	penjador
lluvia	pluja	murciélago	ratpenat	periódico	diari
lobo	llop	muro	mur	perro	gos
loro	lloro	muslo	cuixa	persiana	persiana
luna	lluna	naranja	taronja	peso	pes
mag	mag	nariz	nas	pez	peix
Spanish	Catalan	Spanish	Catalan	Spanish	Catalan
piano	piano	reloj	rellotge	termómetro	termòmetre
pico	bec	remo	rem	tetera	tetera
pie	peu	rey	rei	tiburón	tauró
pierna	cama	rinoceronte	rinoceront	tigre	tigre
pimiento	pebrot	robot	robot	tijeras	tisores
pincel	pinzell	rodilla	genoll	timón	timó
pingüino	pingüí	rodillo	corró	tirachinas	tirador
pintalabios	pintallavis	rombo	rombe	toalla	tovallola
pinza	pinça	rosa	rosa	tobogán	tobogan
piña	pinya	rueda	roda	tocadiscos	tocadiscs
pipa	pipa	sábana	llençol	tomate	tomàquet
pirámide	piràmide	sacacorchos	llevataps	tornillo	cargol
pirata	pirata	sacapuntas	maquineta de fer punta	toro	toro
piscina	piscina	salero	saler	tortuga	tortuga
pistola	pistola	saltamontes	llagosta	trébol	trèvol
pizza	pizza	sandía	síndria	tren	tren
plancha	planxa	sangre	sang	trenza	trena
planeta	planeta	sartén	paella	triángulo	triangle
plátano	plàtan	saxofón	saxofon	trigo	blat
platillo	plateret	semáforo	semàfor	trineo	trineu
plato	plat	serpiente	serp	trípode	trípode
pluma	ploma	seta	bolet	trompeta	trompeta
policía	policia	sierra	serra	tronco	tronc
pollo	pollastre	silbato	xiulet	tuerca	rosca
pozo	pou	silla	cadira	tumba	tomba
puente	pont	sofá	sofà	túnel	túnel
puerta	porta	sol	sol	unicornio	unicorn
pulgar	polze	soldado	soldat	uña	ungla
pulmón	pulmó	sombra	ombra	uva	raïm
pulpo	pop	sombrero	barret	vaca	vaca
puño	puny	submarino	submarí	valla	tanca
puro	puru	taburete	tamboret	vaquero	vaquer
puzzle	puzle	tacón	taló	vaso	got
queso	formatge	taladro	trepant	ventana	finestra
rábano	rave	tambor	tambor	ventilador	ventilador

radio	ràdio	tanque	tanc	vestido	vestit
rama	branca	taza	tassa	vías	via
rana	granota	teclado	teclat	violín	violí
raqueta	raqueta	tejado	teulada	volante	volant
rastrillo	rastell	telaraña	teranyina	volcán	volcà
rayo	llamp	teléfono	telèfon	yunque	enclusa
red	xarxa	telescopio	telescopi	zanahoria	pastanaga
regadera	regadora	televisión	televisió	zapato	sabata
regalo	regal	tenedor	forquilla	zorro	guineu
regla	regla	termo	termo		