Investigating early second language word learning accuracy in a large-scale dataset

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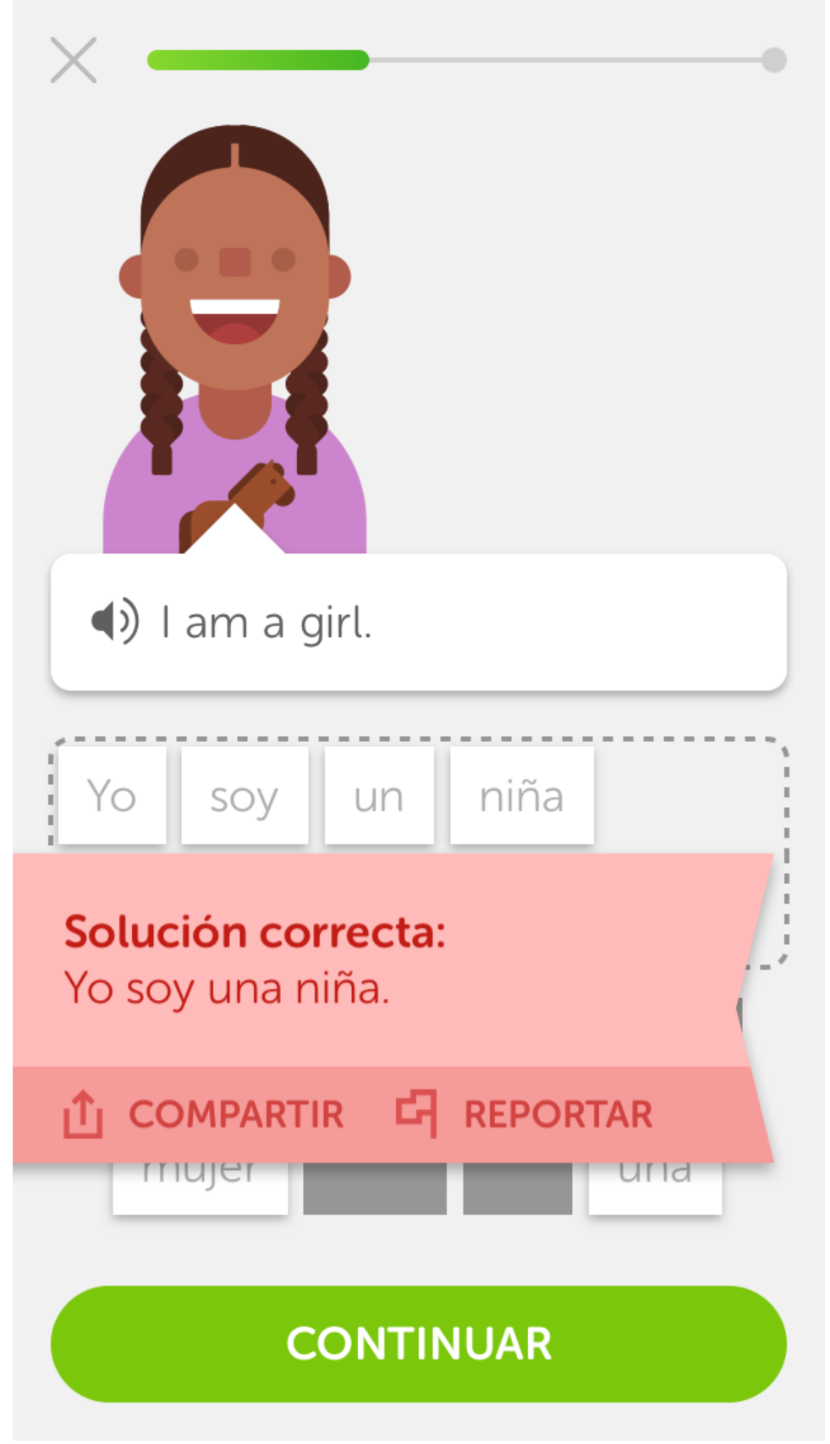
Why are some L2 words harder to learn?

Classroom/experimental studies identified several predictors[1,2,3], but…

- predictors often dichotomized
- predictors usually studies in isolation
- few predictors studied

What is Duolingo?



I am a girl.

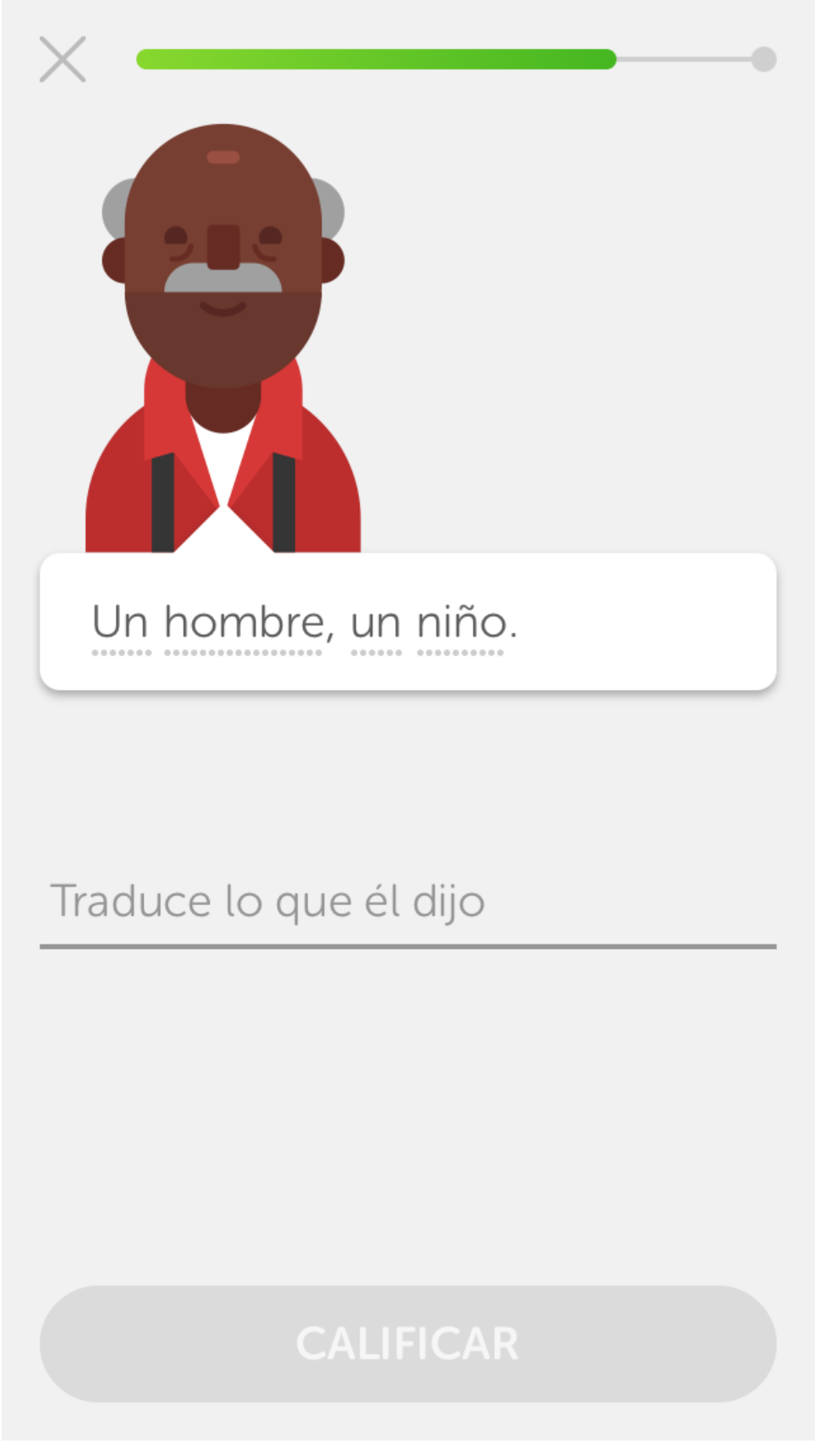
Yo | soy | un | niña

Solución correcta:
Yo soy una niña.

COMPARTIR REPORTAR

mujer | una

CONTINUAR



Un hombre, un niño.

Traduce lo que él dijo

CALIFICAR

Translation "Algorithm"

Google Translate

1. machine translations

2. bilinguals hand-check

What is in the Duolingo dataset?

Example raw user-word observations[4]

Interface Language	UserID	Word	Word Experience	*User Experience*	Times correct	*Proportion correct*
Spanish	u:0Fa	Blue	24	*81*	16	*0.66*
Spanish	u:0Fa	Spider	7	*81*	7	*1*
Spanish	u:0Fa	Eat	20	*81*	18	*0.9*
Spanish	u:0Fa	Until	30	*81*	24	*0.8*

Overall dataset characteristics

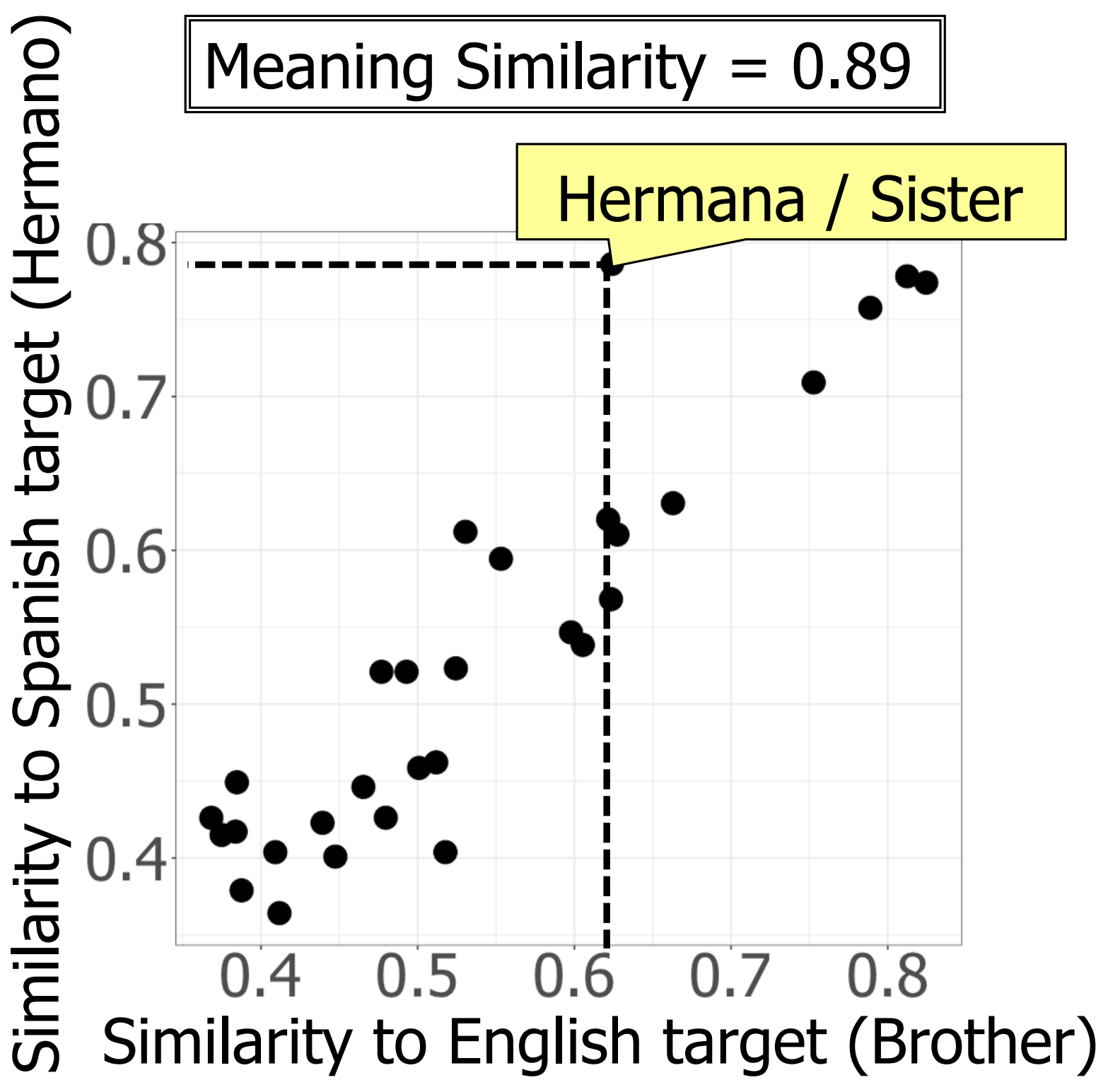
Interface Language	Language Learned	Number of Users	Number of Words	Range of Word Experience	Range of User Experience	Number of observations
Spanish	English	28,107	1,411	3 – 22,336	41 – 392,683	1,197,890
English	Spanish	27,248	1,737	3 – 4,737	41 – 75,664	1,182,191
Portuguese	English	7,713	1,398	3 – 7,991	41 – 40,052	312,088
English	Portuguese	2,395	1,517	3 – 1,540	41 – 13,971	99,633
Italian	English	2,959	1,411	3 – 1,1577	41 – 32,304	152,523
English	Italian	5,522	1,330	3 – 1,104	41 – 17,802	222,925

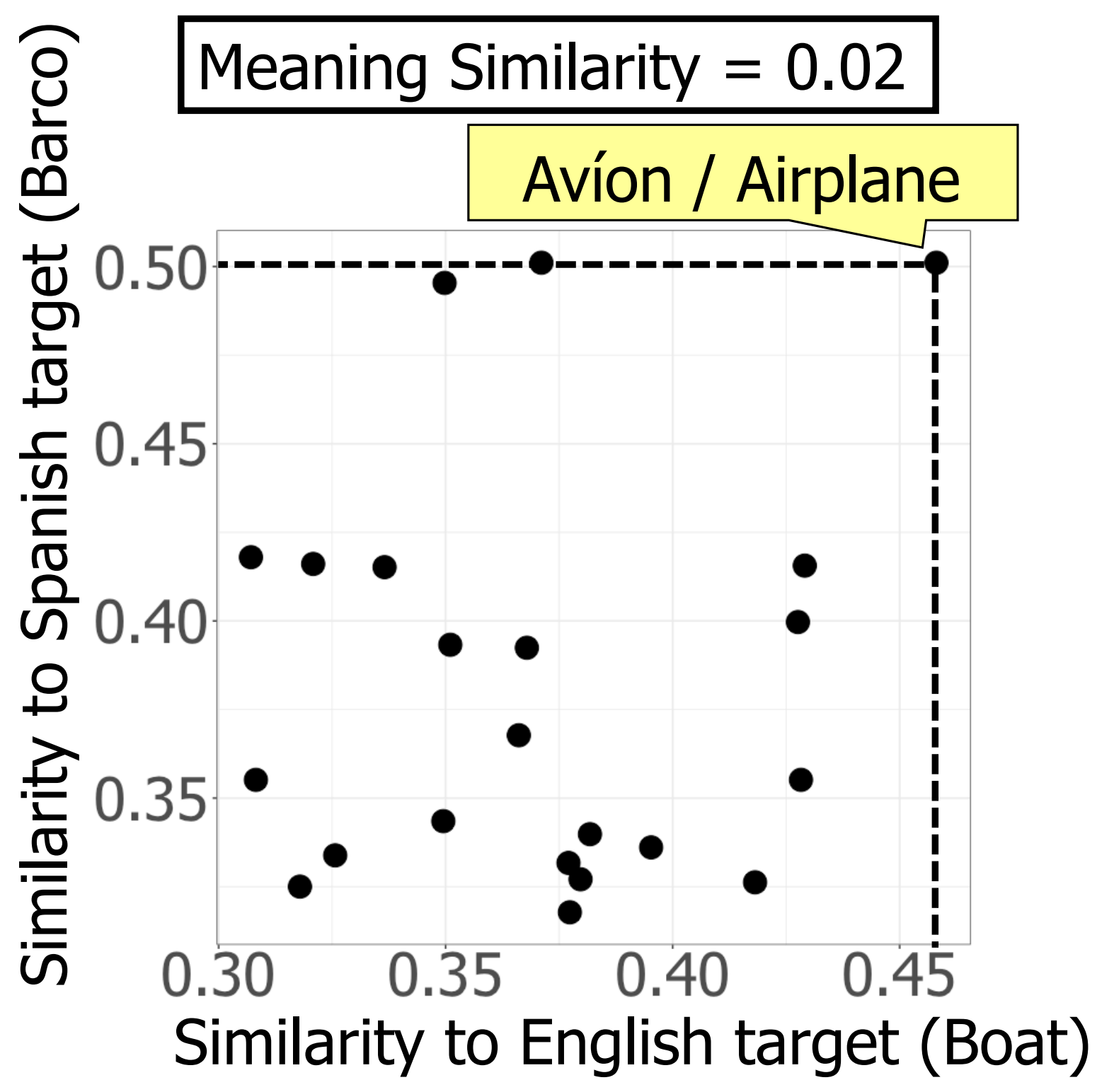
Do translations mean the same?

1. find the 40 closest neighbors[5] to a translation pair
2. find overlapping neighbors between the two languages

rank	Brother	Similarity	Hermano	Similarity	Boat	Similarity	Barco	Similarity
1	uncle	0.82	**hermana**	**0.79**	ship	0.56	**avión**	**0.50**
2	father	0.81	padre	0.78	**airplane**	**0.46**	viaje	0.49
3	son	0.79	tío	0.78	navy	0.43	puerto	0.42
4	grandfather	0.75	hijo	0.77	swim	0.43	tren	0.42
5	daughter	0.66	abuelo	0.76	car	0.43	armada	0.42
6	friend	0.63	hija	0.71	fish	0.42	capitán	0.42
7	**sister**	**0.62**	esposa	0.63	beach	0.42	coche	0.40
8	mother	0.62	quien	0.62	river	0.40	isla	0.39
9	wife	0.62	amigo	0.61	ton	0.38	vehículo	0.39
10	aunt	0.61	marido	0.61	wooden	0.38	hotel	0.38
…	…		…		…		…	
40	family	0.36	abogado	0.36	port	0.36	cuando	0.32

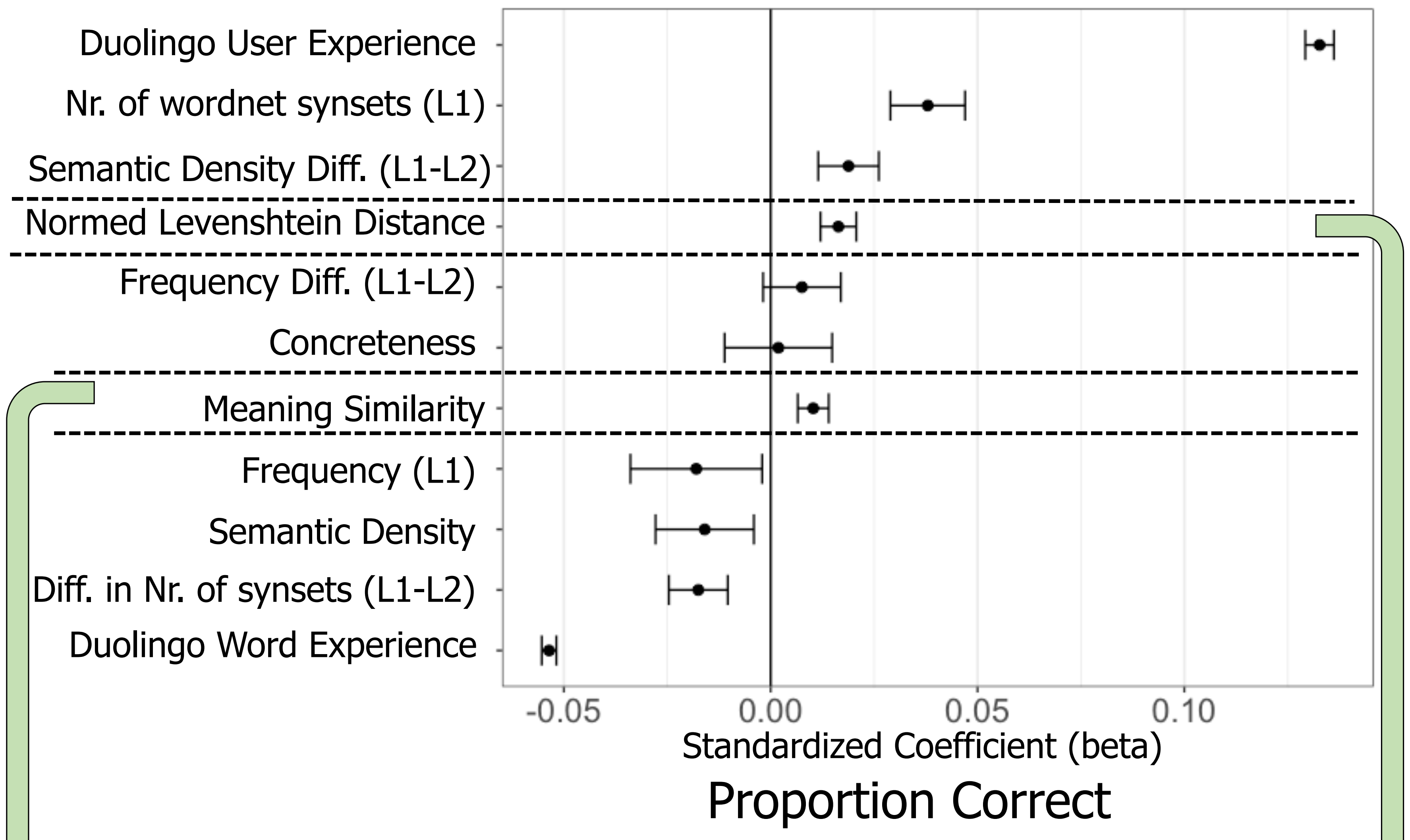
3. Meaning Similarity[6]: overlapping neighbors' rank correlation





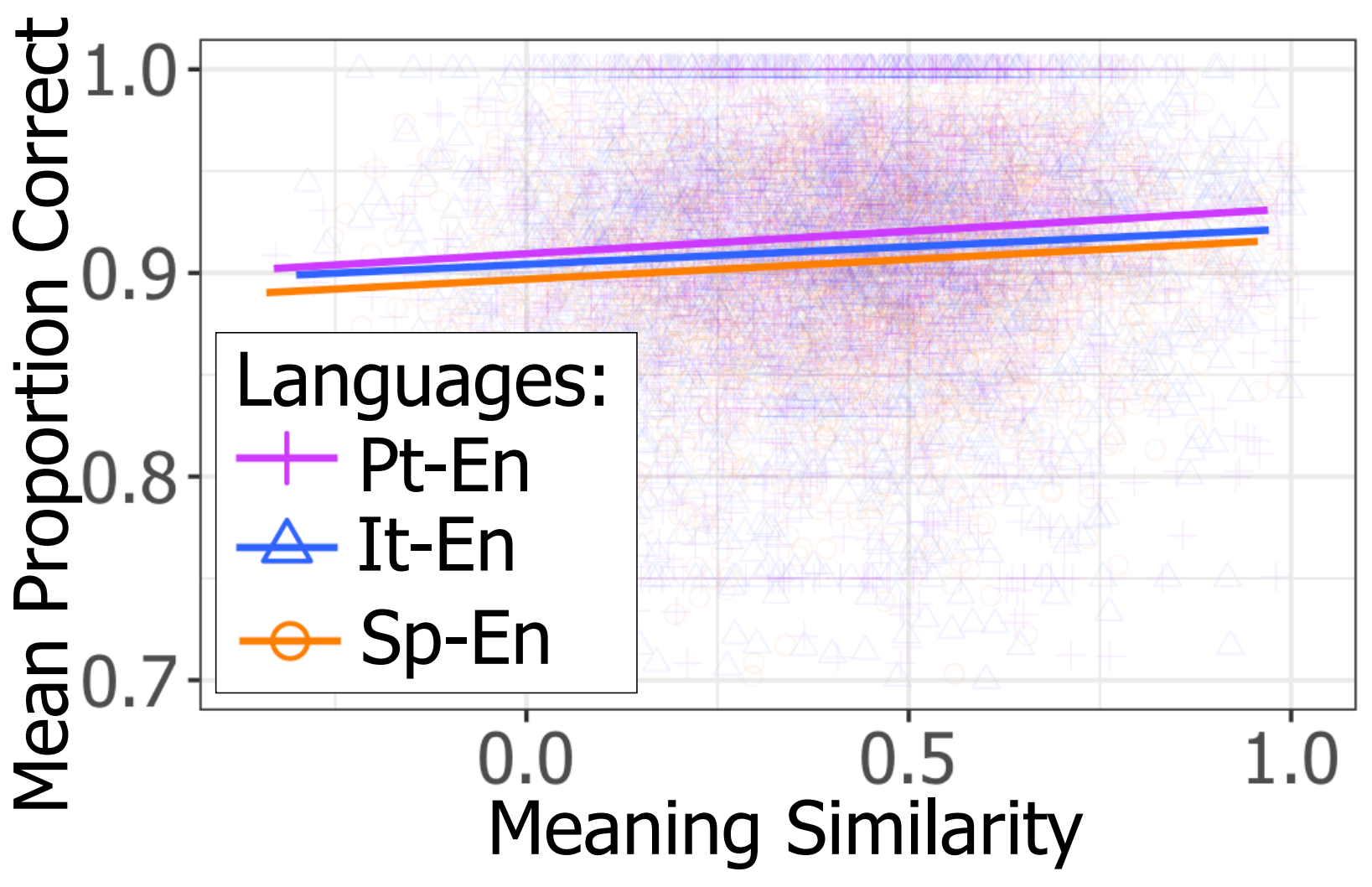
Predicting word learning accuracy

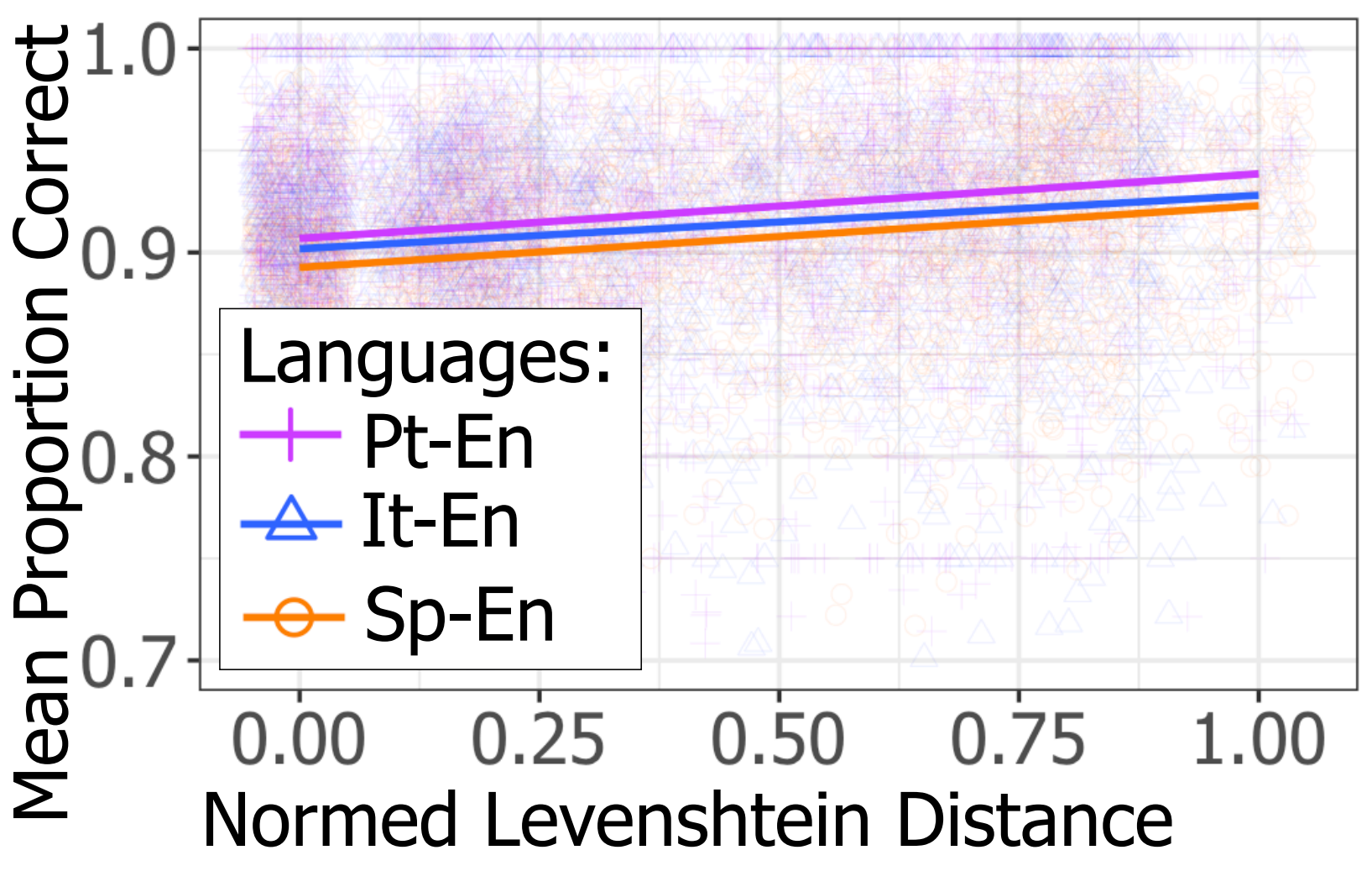
Linear mixed effects regression model results:



higher meaning similarity ⇨ easier to learn

more cognateness ⇨ easier to learn





Our new variable **Meaning Similarity** is predictive of word learning accuracy!

A continuous measure of **Cognateness** is predictive of word learning accuracy!

References

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Challenges and open questions

- Duolingo's algorithm oversamples words people find hard
- Given biased statistics in this dataset, what are appropriate statistical models?
- Combinatorial explosion of potential interactions
- How do these analyses inform cognitive theories of word learning?
- What can asymmetries in learnability tell us?