Beyond Timing Gaps:
Phonological Norming For The California Cognitive Assessment Battery In Spanish

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Introduction

The California Cognitive Assessment Battery (CCAB) is a remotely-monitored automated assessment capturing speech measures from verbal tasks that may inform models of cognitive health.

Speech-based timing metrics are subject to language-specific influences that can distort results and mischaracterize impairment. Spanish words are on average longer (more syllables) than English equivalents, inflating completion times independent of cognitive ability.

Phonological length effects are well-documented in the working memory literature yet rarely accounted for in cross-language cognitive assessment.

Methods

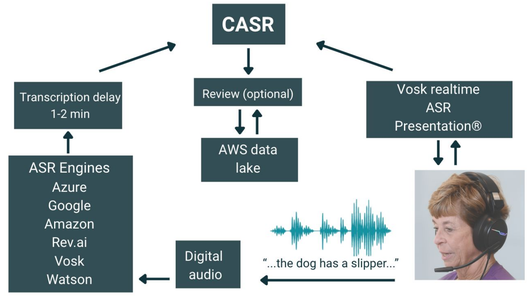
Participants: The California Cognitive Assessment Battery (CCAB) was administered to 169 healthy adult native Spanish speakers during ongoing normative data collection. Participants completed a range of cognitive tasks, including verbal response tasks.1:1 nearest-neighbor matching from an English speaking Latino cohort on age, education, gender, and vocabulary yielded 164 matched pairs (Spanish: M age=47.1, SD=13.8, 60% female; English: M age=46.9, SD=13.8, 60% female; all p > .49).

CCAB Español: The Spanish language version of CCAB was carefully adapted and translated to match psychometric properties of the English version. This adaptation took into account dialectal variation, cultural and regional differences, and linguistic characteristics.

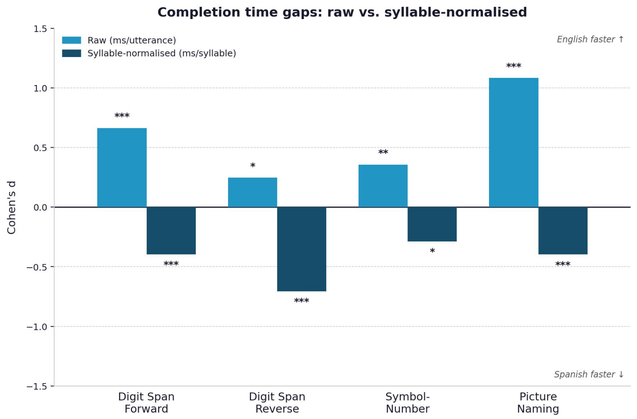
Technology: Participants were tested in their own homes using a tablet computer with circumaural headphones and a head-mounted microphone. Instructions and stimuli were delivered using text-to-speech (TTS) in Spanish, with intensities adjusted to the participant's auditory threshold. Responses were automatically transcribed using consensus automatic speech recognition (CASR). An examiner remotely monitored participant performance over audio and visual feeds.

Tasks: Four verbal tasks are analyzed here: Digit Span Forward/Reverse (DSF, DSR), Symbol-Number (SN), and Continuous Picture Naming (CPN). Syllable counts were derived from transcripts produced by the CASR pipeline (below).

Consensus ASR pipeline: digital audio files are passed to multiple ASR engines, and then enter a weighted voting algorithm (CASR). Realtime ASR informs both CASR and realtime results reporting. Transcripts are optionally reviewed and stored in AWS before entering scoring pipeline.



Results



Section	Task	Measure	Spanish M (SD)	English M (SD)	Cohen's d	p
Raw time per utterance (ms)	DSF	TPU (ms/digit)	794 (155)	685 (175)	**0.66**	**<.001** ***
	DSR	TPU (ms/digit)	987 (196)	937 (209)	**0.25**	**0.039** *
	CPN	TPU (ms/item)	1208 (327)	921 (184)	**1.08**	**<.001** ***
	SN	TPU (ms/resp)	2071 (418)	1933 (355)	**0.36**	**0.002** **
Time per syllable (ms)—syllable-normalized	DSF	TPU/syl	73 (33)	89 (46)	**-0.40**	**<.001** ***
	DSR	TPU/syl	111 (42)	146 (57)	**-0.71**	**<.001** ***
	CPN	TPU/syl	510 (147)	562 (115)	**-0.40**	**<.001** ***
	SN	TPU/syl	1463 (294)	1547 (292)	**-0.29**	**0.012** *
Accuracy / span	DSF	Mean span	5.21 (1.29)	6.30 (1.60)	**-0.75**	**<.001** ***
	DSR	Mean span	4.41 (1.24)	4.83 (1.58)	**-0.30**	**0.008** **
	CPN	Items named	50.2 (8.9)	51.6 (11.2)	-0.14	0.241
	SN	Accuracy	0.965 (0.101)	0.944 (0.157)	0.14	0.243

Figure 1: (Left) Bar graph with task on the x-axis, and Cohen's d (effect size magnitude) on the y-axis. Analysis of raw values are in light blue, syllable normalized analysis is in dark blue. Positive values indicate an English advantage, negative values indicate a Spanish advantage. (Right) Table of mean measure values and standard deviations by task and language group, with Cohen's d and associated p-values. English speed advantage is eliminated when normalized by syllables produced. Abbreviations: Digit Span Forward (DSF), Digit Span Reverse (DSR), Continuous Picture Naming (CPN), Symbol-Number (SN)

Summary

All four tasks showed raw time per unit (TPU) gaps favoring English speakers (Cohen's d: DSF: d=0.64; DSR: d=0.26; CPN: d=0.54; SN: d=0.27). However, Spanish TPU ratios were frequently below those predicted by syllable counts alone.

Syllable normalization eliminates the apparent disadvantage for Spanish speakers on naming and symbol-number tasks. Spanish speakers are generally **faster** per syllable.

Span differences in Forward and Reverse Digit Span reflect theoretically expected phonological rehearsal effects on working memory capacity, not measurement artifacts.

Timing gaps should not be interpreted as indicators of greater cognitive risk, and support the development of language specific norms.

Discussion

Raw completion times on cognitive tasks with verbal responses systematically overestimate gaps between Spanish- and English-language administrations due to phonological word-length differences.

After syllable normalization, Spanish participants demonstrated faster or equivalent processing speed per syllable. These findings argue for syllable-adjusted norms on verbal timing measures in multilingual assessment.

Clinicians should not interpret raw verbal completion time differences as evidence of cognitive impairment in Spanish-speaking patients. Furthermore, tasks that involve phonological working memory should have language-specfic norms

This finding has implications for other tasks where verbal responses are constrained by time, e.g. Verbal Fluency, in which fewer lexical items but equivalent or increased syllable counts may occur in Spanish language responses.

References

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