Evidence for shared knowledge and access processes across comprehension and production: Literacy enhances spoken word comprehension *and* word production

Florian Hintz, Merel C. Wolf, Caroline F. Rowland, & Antje S. Meyer (Max Planck Institute for Psycholinguistics)
Florian.Hintz@mpi.nl

The ability to read offers users of a spoken language an additional modality for using language, next to speaking and listening. Previous research has shown that frequent reading has positive effects on language processing. As one would expect, frequent reading enhances reading skills (Mol & Bus, 2011). More interestingly, recently, experimental studies have demonstrated that the effects of literacy extend to spoken language processing. For instance, Favier and colleagues (in press) showed that literacy predicted people's ability to anticipate upcoming words in spoken sentences, with frequent readers having better prediction skills than infrequent readers. One account for these findings is that – compared to infrequent readers – frequent readers have 'sharper' or 'more entrenched' lexical representations, which they obtained through extensive exposure to written text (Diependaele et al., 2013; Huettig & Pickering, 2019). Sharpened lexical representations can be retrieved fast and reliably during language processing, for example in the service of prediction during comprehension (Favier et al., in press). Crucially, if enhanced literacy leads to sharpened lexical representations and efficient lexical retrieval, frequent readers should also display advantages over infrequent readers in word-level (i.e., non-predictive) comprehension. Moreover, prominent theories of language processing assume that comprehension and production draw on shared linguistic knowledge and shared access processes and are in essence "facets of a unitary skill", (e.g., Chater et al., 2016). On such an account, the effects of literacy should transfer and also enhance language production skills.

In the present study, we tested these hypotheses using an individual-differences approach. We re-analyzed a large, publicly available dataset suitable for studying individual differences in language skills and general cognitive skills involved in language. The dataset contains data from 112 young adults (aged between 18 and 29 years), acquired in a lab-based setting using a recently developed behavioral test battery (Hintz et al., 2020). We applied a latent-variable approach and conducted principal component analysis. Using a variety of behavioral tests (see Table 1 for tests & factor loadings and Fig. 1 for correlations among factors and IQ), we operationalized 'literacy', 'spoken word comprehension', 'word production', and 'non-verbal processing speed' ability. The literacy factor relied on the same five tests as used by Favier et al. (in press). Word comprehension and word production ability was operationalized by using three and five tests, respectively, that tapped into word form access/retrieval, phonological processing, and semantic processing. Processing speed ability was assessed using five auditory and visual reaction time tests. As a test of non-verbal intelligence, we included Raven's Advanced Progressive matrices (Raven et al., 1999). Per participant, we obtained one score for each of the four factors. These scores were submitted to correlation and regression analyses. Word comprehension and production scores were significantly correlated ($r = .24$). Literacy correlated with both comprehension ($r = .39$) and production ($r = .59$) scores. The regression analyses revealed that literacy explained substantial portions of variance in both word comprehension and word production, over and above the influences of non-verbal processing speed and general intelligence.

These findings provide further evidence that extensive exposure to written text enhances spoken language use. We observed that higher levels of literacy were associated with better spoken word comprehension ability. In line with prominent psycholinguistic theories, we found that individuals' literacy skills also predicted word production abilities. Our data therefore support the notion that frequent reading sharpens lexical representations that can be retrieved and used efficiently for language processing. Moreover, at least for word-level processing, the data support the notion that comprehension and production draw on shared linguistic knowledge and access processes.

Table 1: Loadings of the individual tests on the construct they were assumed to measure as well as the amount of variance explained, established using PCA (oblimin rotation, regression-based scores).

Literacy factor	**Word comprehension**	**Word production**	**Processing speed factor**
56% variance explained	81% variance explained	42% variance explained	53% variance explained
Receptive vocabulary .72	Word form access .91	Word form retrieval .66	Auditory speed I .71
PPVT-III	*Lexical decision*	*Picture naming*	*Auditory simple RT*
Spelling .8	Phonological processing .88	Semantic processing I .58	Auditory speed II .83
Spelling test	*Rhyme judgment*	*Antonym production*	*Auditory choice RT*
Literary experience .78	Semantic processing .91	Semantic processing II .76	Visual speed I .74
ART	*Semantic categorization*	*Verbal fluency: Categories*	*Visual simple RT*
Word reading .69		Phonological processing .68	Visual speed II .81
One-minute test		*Verbal fluency: Letters*	*Visual choice RT*
Non-word reading .75		Speeded production .53	Visual speed III .48
Klepel test		*Maximal speech rate*	*Letter comparison*

Note: Non-verbal intelligence is not listed as it was measured using a single test.

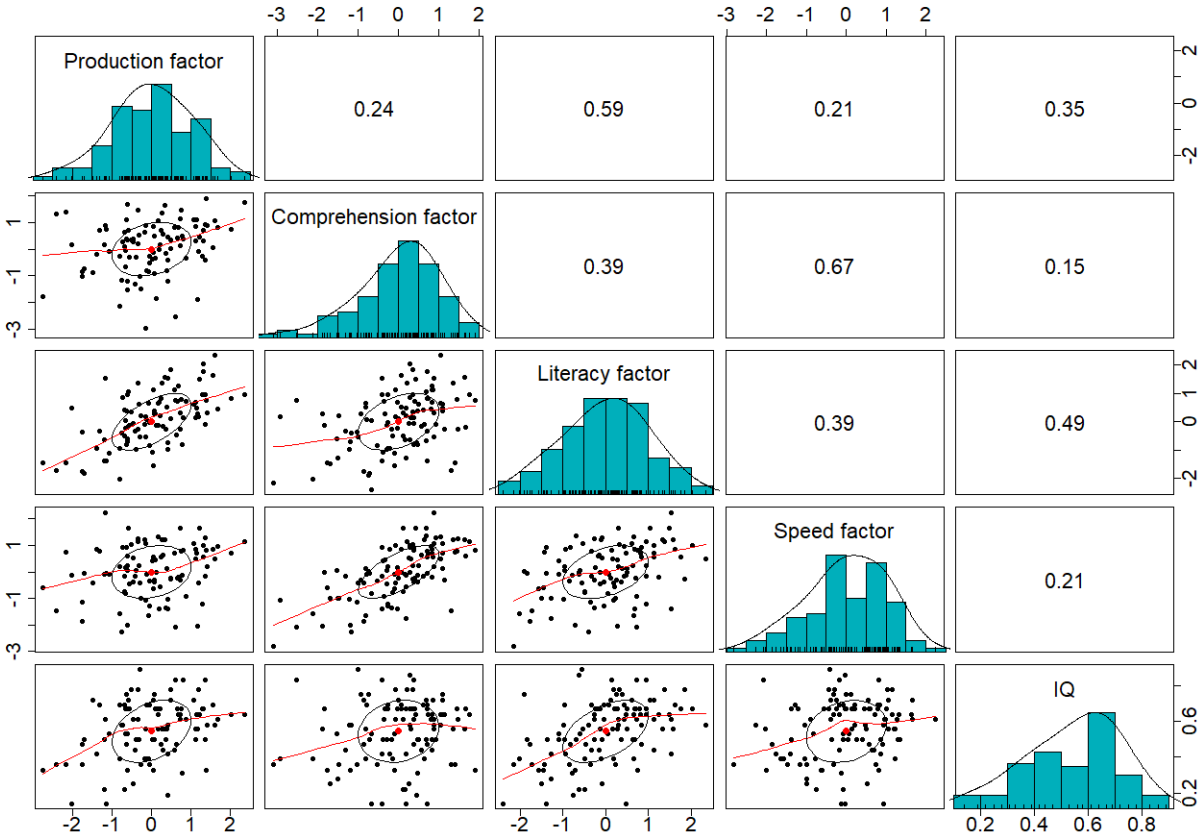

Figure 1: Correlations between word production, word comprehension, literacy, and speed factors and IQ.

References

Chater, N., McCauley, S. M., & Christiansen, M. H. (2016). Language as skill: Intertwining comprehension and production. *Journal of Memory and Language, 89*, 244-254.

Diependaele, K., Lemhöfer, K., & Brysbaert, M. (2013). The word frequency effect in first-and second-language word recognition: A lexical entrenchment account. *Quarterly Journal of Experimental Psychology, 66*(5), 843-863.

Favier, S., Meyer, A. S., & Huettig, F. (in press). Literacy can enhance syntactic prediction in spoken language processing. *Journal of Experimental Psychology: General.*

Hintz, F., Dijkhuis, M., Van 't Hoff, V., McQueen, J. M., & Meyer, A. S. (2020). A behavioural dataset for studying individual differences in language skills. *Scientific Data, 7*: 429.

Huettig, F., & Pickering, M. J. (2019). Literacy advantages beyond reading: Prediction of spoken language. *Trends in Cognitive Sciences, 23*(6), 464-475.

Mol, S. E., & Bus, A. G. (2011). To read or not to read: A meta-analysis of print exposure from infancy to early adulthood. *Psychological Bulletin, 137*(2), 267–296.