Contributions of declarative and procedural memory to accuracy and automatization during L2 practice.

Recent developments in the study of individual differences in L2 development have highlighted the role of declarative and procedural learning ability as important L2 predictors of attainment in grammaticality judgment tests (e.g., Faretta-Stutenberg & Morgan-Short, 2018; Hamrick, Lum, & Ullman, 2018; Morgan-Short, Faretta-Stutenberg, Brill-Schuetz, Carpenter, & Wong, 2014). At least two other studies have examined the role of these individual differences for accuracy by tracking attainment over a more fine-grained time course during L2 practice (Pili-Moss, 2018), or have investigated the relationship between procedural learning ability and automatization (Suzuki, 2017). However, no studies to date have simultaneously looked at the role of both learning abilities for the development of L2 accuracy and automatization during practice.

In the artificial language learning task employed in Morgan-Short et al. (2014), the present study aimed to look at how declarative and procedural learning ability contributed to attainment during practice investigating their relationship longitudinally with measures of accuracy in L2 comprehension and production and of automatization in L2 comprehension, as reflected by the coefficient of variation (CV; Segalowitz, 2010).

Fourteen monolingual speakers of English were trained in Brocanto2 (a fully meaningful and productive artificial language) in the context of a computer board game similar to draughts over four sessions (two weeks). After a vocabulary training phase and aural exposure to the language in implicit learning conditions, the participants practiced using the language by playing a computer board game that alternated between two comprehension and two production blocks for a total of 72 blocks (12 blocks on session one and 20 blocks per session thereafter, 1440 stimuli in total). In the comprehension blocks, the participants were asked to perform game moves after hearing a corresponding Brocanto2 stimulus sentence, whilst in the production blocks, participants described a move they saw on screen using the artificial language.

Beside accuracy scores (comprehension and production blocks), reaction times (RTs) were also collected for comprehension, and the corresponding CV was calculated as an index of automatization (Segalowitz, 2010). Mixed-effects models of the accuracy data revealed that declarative learning ability was a significant predictor of accuracy in comprehension throughout practice, whilst procedural learning ability did not predict accuracy in either comprehension or production. Further, modelling of the CV data revealed that procedural learning ability, as well as a positive interaction between declarative and procedural learning ability, were significant predictors of automatization.

Overall, these results confirm the role of declarative learning ability in the early stages of adult L2 development. Furthermore, they provide the first behavioural evidence the author/s are aware of for the predictive role of procedural learning ability in the early stages of automatization, supporting the predictions of current applications of Skill Acquisition theory to L2 development (e.g., DeKeyser, 2015). Finally, an interaction between declarative and procedural learning ability would also be compatible with recent cognitive models envisaging the possibility of co-operative interaction between the declarative and the procedural memory systems in the acquisition and processing of a second language (Ullman, 2005; 2016).

Hamrick, P., Lum, J. A. G., & Ullman, M. T. (2018). Child first language and adult second language are both tied to general-purpose learning systems. *Proceedings of the National Academy of Sciences*, *115*, 1487–1492. doi:org/10.1073/pnas.1713975115

Morgan-Short, K., Faretta-Stutenberg, M., Brill-Schuetz, K.A., Carpenter, H. & Wong P.C.M. (2014). Declarative and procedural memory as individual differences in second language acquisition. *Bilingualism: Language and Cognition, 17*, 56-72.

Pili-Moss, D. (2018). *The earliest stages of second language learning. A behavioral investigation of the role of long-term memory and age*. Ph.D. dissertation, Lancaster University.

Segalowitz, N. S. (2010). *Cognitive bases of second language fluency*. New York: Routledge.