CHAPTER 13

Task-based analysis and the Competition Model

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This chapter examines relations between Peter Skehan's task-based analysis of second language production (Skehan, 1998) and the Competition Model (MacWhinney, 2012, 2015b). Both of these approaches have a long history of development. However, until recently, there has been little interaction between these two perspectives. In this paper, I will suggest that there is more room for interaction than previously imagined, and I will illustrate ways in which the Competition Model can benefit from the important insights and methods Skehan has developed. In addition to these conceptual interactions, there are now important methodological interactions that are becoming possible through the development of the new FluencyBank system at <https://fluency.talkbank.org>.

Research in the classic version of the Competition Model had mostly ignored the crucial issue of second language fluency, largely because of its emphasis on measuring comprehension, rather than production. However, the newer formulation, called the Unified Competition Model (MacWhinney, 2012), has sought to fill this gap, and Peter Skehan's work can play an increasingly important role in that development. The core area of overlap between these two approaches involves Skehan's analysis of the trade-off during speech production between complexity, accuracy, lexical complexity, and fluency (CALF), based on a Limited Attention Capacity (LAC). The idea of a trade-off arising from a competition between systemic constraints is also fundamental to the Competition Model, which views language structure as arising from the competition between communicative functions or motivations in online processing, language acquisition, and historical language change (MacWhinney, 2014a, 2015a). Across three decades of research, the model has maintained this emphasis on competing functional motivations, while continually striving to extend this analysis to new dimensions of language use and language users.

In order to provide sharp experimental contrasts, Competition Model studies (MacWhinney & Bates, 1989) often focused on the competition between motivations for case assignment in transitive sentences. For example, in the English Active mood, the grammatical Subject is the Agent and the Direct Object is the Patient.

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However, in the Passive mood, these relations are reversed. Along with the motive of Agency, the selection of a referent as Subject is supported by the functional motivations of topicality, focus, and givenness (Bates, McNew, MacWhinney, Devescovi, & Smith, 1982). However, when a speaker wishes to align these additional motives with the Patient, they use the Passive construction instead of the Active. Our first studies of this process in English, Italian, and Hungarian (MacWhinney & Bates, 1978) used variations in the combinations of these motives in the contexts for picture description to induce alternative constructions in sentence production. Although Hungarian has no Passive, it can express topicality separately from agency by placing the topic in initial position before a slight pause, while leaving the device of Subject-Verb agreement for the marking of agency. Italian uses word order variations to map alternative configurations of these motives.

These early studies of competing motivations for the Agent role selection during production were useful for elaborations of the theory for both first and second language learners. However, the administration, transcription, and scoring of picture and film descriptions is difficult and time-consuming. As a result, like many other psycholinguists, we turned our attention to the study of competing motivations in comprehension, rather than production. This allowed us to achieve tighter control of stimulus construction, stimulus presentation, response timing, and statistical analysis. We were also able to provide a clear computational implementation of the model based on the theory of item-based patterns (MacWhinney, 1982, 2014b) that undergo unification during the process of immediate incremental sentence interpretation (O'Grady, 2005), as well as through neural network models of lexical development (Li, Zhao, & MacWhinney, 2007).

Using these frameworks, we were able to measure the strengths of cues for sentence comprehension in English, Italian, Hungarian, and German (McDonald & MacWhinney, 1989). We then extended the analysis to study processing by first and second language learners. We found that children begin language learning by relying on canonical sentence prototypes that maximize cue convergence. Second language learners, on the other hand, are heavily influenced by the transfer of cues and cue strength from their first language. For example, McDonald (1987) showed that English-speaking learners of Dutch first process transitive sentences by relying on the preverbal positioning cue that is the dominant cue in English. However, over time they come to rely increasingly on case marking, because of its greater importance in Dutch. Dutch-speaking learners of English demonstrate the opposite pattern, relying first on case marking and only gradually shifting to a reliance on preverbal positioning. Apart from Agent assignment, it was also possible to use these methods to study competitions for pronominal referent assignment, relative clause interpretation, indirect object assignment, and marking of definiteness through the article. Competition Model studies have examined a wide range of cues that are involved in these competitions, including case-marking, word order patterns, subject-verb agreement, object-verb agreement, honorific marking on the verb, gender and number agreement, and contrastive stress.

This focus on experimental tests of cue competition during comprehension produced an coherent view of learning and processing for comprehension. However, it failed to provide an account of learning and processing for production. To remedy this core omission, the Unified Competition Model focuses on the growth of fluency, along with many of the patterns of the CALF trade-off that Skehan has documented.

To understand these theoretical overlaps, we can begin by focusing on Competition Model accounts for experimental findings on the CALF trade-off. Based on an analysis of the TBLT research literature, Ellis (this volume) concludes that the core axis of the CAF trade-off is between complexity and fluency on the one hand and accuracy on the other. This finding is echoed in the results reported by Bui (this volume) for the fuller CALF model. The Competition Model views this pattern as arising from the fact that sentential complexity emerges from fluency, whereas lexical complexity is linked to formal accuracy. Following Anderson (1983) and Ullman (2004), the model holds that accuracy and lexical complexity are supported by the hippocampal-cortical circuits for storing declarative knowledge, whereas fluency and sentential complexity are supported by basal ganglia circuits for procedural learning. During processing, these two systems compete for attentional resources. At the same time, the systems must cooperate to provide accurate lexical insertion in syntactic constructions. It is this pattern of competition linked to cooperation that produces much of the complexity in the trade-off between these systems.

In addition to highlighting the role of these two systems for language consolidation, the Competition Model emphasizes the role of mental model elaboration in language production, much as in Levelt's (1989) account of conceptualization driving formulation and articulation. In the Competition Model, these processes are described in terms of a system of perspective shifting and maintenance (MacWhinney, 2008) that controls the dimensions of embodied agential action, spatial localization of activities, and referential anaphora.

In developmental terms, the model holds that, for both L1 and L2 learners, clauses and sentences are constructed through combinations of item-based patterns and their generalization into feature-based patterns that govern the syntactic properties of lexical groups (MacWhinney, 2014b). A simple example of an item-based pattern would be *more* + *X* in which the operator item *more* can combine with any common noun as the slot filler in X. A simple example of a feature-based pattern is the combination of *ADJ* + *N* that governs the attachment of the adjective to a following noun in English. Combining such patterns can yield forms such as *more hot chocolate*, *more blank paper*, and so on.

Fluency

The initial acquisition of lexically-based patterns arises through hippocampal-based learning (Schapiro, Turk-Browne, Botvinick, & Norman, 2017), leading to representation of these patterns in the anterior temporal lobe (ATL) (Kemmerer, 2015). However, the fluent consolidation and integration of these patterns relies on basal ganglia-based proceduralization (Dominey, Hoen, & Inui, 2006; Stocco, Lebiere, & Anderson, 2010) and control from the inferior frontal gyrus (IFG) or Broca's area. In the item-based pattern model (MacWhinney, 2014b), clauses and sentences are built up through the operation of clustering, which is similar to the operation of Merge in UG, but is based on surface lexical items and lexical groups, rather than abstract universal structures. (For further details please consult MacWhinney, 2014b). In order to express increasingly complex concepts, learners must rely on an increasingly rich set of item-based and feature-based patterns and must practice their use in forming clustered structures in both comprehension and production. In this account, breakdowns in fluency can arise from several sources that can be ordered in a developmental sequence:

1. Until a new lexical item or item-based syntactic pattern is learned through initial declarative encoding, it cannot become proceduralized.
2. Often the phonological shape of new forms must be refined over time. For example, learners may acquire Chinese words without correctly representing their tone. Until these tones are clearly encoded, there can be uncertainty in lexical access leading to disfluency. Some of the disfluencies noted by Xing and Luo (this volume) seem to involve problems at this level.
3. Once acquired, item-based syntactic patterns can be generalized further into feature-based patterns or constructions. Until this level of generalization is reached, the learner will not be able to combine constructions fluently. The result will be a lower level of both complexity and fluency.
4. Once fluent control of feature-based patterns is achieved, the learner must work on the coordination of units into higher structures through processes of clause combination or elaboration of the nominal and verbal phrases. This development can support what Skehan, Foster, and Shum (2016) call "clause fluency". Breakdowns can occur if devices for marking subordination or the ordering of adjectives and auxiliaries are not well practiced or if the learner is not focusing on overall construction of a message. As Xing and Luo (this volume), Sasayama and Norris (this volume) and Raquel et al. (this volume) note, tasks that are rich in germane conceptual structure, but still accessible to the learner, can facilitate activation of more complex discourse fluency linkages.

5. Once learners have controlled the linkage and clustering of the elements of fluent compositions, they must still deal with real-time coordination of lexical access and insertion from temporal lobe structures and the gating of specific articulations in inferior frontal cortex and motor cortex. This type of just-in-time coordination also poses challenges for native speakers, resulting in occasional speech errors. The challenge is even greater for second language learners. The fact that proceduralized structures minimize attentional requirements means that they can resist interference from competing tasks (Anderson, 1983). This then helps to minimize errors and to support higher levels of fluency.
6. Once these lower levels have come under control, learners must still be able to deal with possibly extreme task demands (Skehan 2014). When confronted with very difficult tasks, including conversational challenges (Schegloff, 2007), learners can only perform fluently if they can handle both mental model construction, conversational interaction, and discourse fluency at the same time. As noted by Dornyei (this volume), integration on this level can be supported by "directed motivational currents" that keep the speaker focused and on target.
7. On each of these levels of fluency development, the forms produced by a learner can become more complex through task repetition (Gass, Mackey, Alvarez-Torres, & Fernández-García, 1999). This occurs because repeated passes over lexical forms, syntactic structure, and articulatory patterns can activate the component pieces, permitting smoother real-time integration. Apart from producing more fluent productions, repetition can also lead to long-term gains in production accuracy and fluency (de Jong & Perfetti, 2011).

As suggested by Bui (this volume) and Tavakoli (this volume), the fact that fluency requires solidification across these various dimensions, and the fact that this solidification can take months or years, means that one cannot expect that there would be some single measure of overall fluency. This point is made in nearly every chapter in this volume. Moreover, there are important individual differences in basic processes for neural transmission, neural connectivity, mental model construction (MacWhinney, 2008) and motor control (Derwing, Munro, Thomson, & Rossiter, 2009) that will impact fluency in both L1 and L2.

On the methodological front, researchers, such as Lambert (this volume), have been taking advantage of the methods available in the TalkBank CLAN program for studying fluency. These interactions can develop even more quickly in the context of the FluencyBank project <https://fluency.talkbank.org> which is configuring an array of automatic measures of fluency in the new FluCalc program. FluCalc is designed to study patterns of disfluency in stuttering, second language learning, aphasia, and normal language processing. Given a transcript in the CHAT format, TalkBank provides methods for automatic tagging of part of speech (on the %mor line) and automatic syntactic dependency analysis (on the %gra line). Given this automatically computed information, FluCalc can then tabulate the relations of retraces, repetitions, and pauses to specific lexical items (on the main line), lemmas (on the %mor line), parts of speech (on the %mor line), and syntactic relations (on the %gra line). CLAN can also automatically compute measures of lexical diversity such as as vocD (McKee, Malvern, Richards, & Knott, 1998) or MATTR (Covington, 2007), along with a wide variety of measures of grammatical complexity. For transcripts that are linked to audio, it is possible to automatically compute segment duration, pause duration, and other duration features. By applying these various automatically computed measures to transcripts created from TBLT studies, we will gain a fuller understanding of the specific components of fluency in line with analyses presented in several chapters in this volume.

Complexity

The analysis of the development of fluency given above is closely linked to the analysis of the development of sentential and discourse complexity. In fact, it is almost impossible to think of the growth of fluency without at the same time referencing the growth of structural complexity. If our productions would involve nothing but a quickly produced string of unrelated words, then we could possibly achieve fluency without complexity. However, the resultant communications would be virtually meaningless. As we try to link ideas together through relations in mental models and clustering in clauses, sentences, and discourses, we are continually compiling smaller procedures into large procedures. As Gobet (2005) argues, these higher-level procedural compilations are not frozen rote forms, but rather flexible structures that allow insertions of elements by type. As noted earlier, the theory of item-based patterns views these combinations as arising through the process of clustering. If specific patterns of clustering are well-practiced, they can consume relatively little attention. However, before these patterns are fully proceduralized, combination can require resource allocation, leading to disfluency. This means that the process of proceduralization is central to the attainment of fluency, particularly as we attempt to produce increasingly complex utterances.

The contrast between hippocampal declarative consolidation and basal ganglia procedural consolidation is reflected in the fact that we can refer to two fundamentally different types of complexity. Lexical complexity, or what Skehan (2014) calls "code complexity" can be measured by scales such as vocD (McKee et al., 1998) or MATTR (Covington, 2007). This type of complexity arises from the acquisition of new forms, new relations, and new patterns of polysemy (MacWhinney, 1989) in the hippocampal-cortical system. Sentential and discourse complexity, on the other hand, can be measured through scales such as the subordination index or propositional density (Brown, Snodgrass, Kemper, Herman, & Covington, 2008). This is the type of complexity that arises first from the desire to express complex relations and which is then supported by the ongoing proceduralization of complex combinatorial patterns.

Accuracy and lexical complexity

Work in the Competition Model framework has typically paid more attention to measuring the growth of accuracy than to measuring the growth of fluency. Moreover, until recently, Competition Model studies have not attempted to modify or improve the course of acquisition. More recently, Competition Model studies in the e-CALL framework (Presson, Davy, & MacWhinney, 2013) have sought to improve learner accuracy through online tutorial systems that target the learning of particular lexical systems. The core assumption here is that improvements in grammatical accuracy often hinge on the proper encoding of lexical forms (MacWhinney, 2014b; Nation, 2001). In addition, to speak fluently, one often has to be able to find the right word to express a concept. As Lambert (this volume) shows in his microgenetic analysis of picture descriptions in a single learner, fluency can be negatively impacted when a speaker cannot find the right word to express a concept. In such cases, a learner may devise circumlocutions or other strategies to compensate for a lack of lexical accuracy. However, knowing the right word for a concept serves as a better support for fluency. In general, low lexical complexity interferes with advances in fluency. This problem involves other lexical aspects besides basic knowledge of content words. For example, a major challenge facing learners of languages like German or Russian with complex markings of case, gender, and number involves the assignment of individual nouns to gender categories, based on a wide variety of cues and rote learning (MacWhinney, Leinbach, Taraban, & McDonald, 1989). Similarly, as we noted earlier, encoding of Chinese words requires careful attention to tones in ways that are not familiar to learners whose first language has no tones. Also, the exact nature of the case and prepositional arguments of verbs varies markedly from language to language. All of these lexical facts impact first the accuracy of lexical retrieval and then production fluency.

Based on these analysis, we have designed e-CALL tutors that target the learning of Chinese vocabulary (Pavlik et al., 2007), French nominal gender (Presson, MacWhinney, & Tokowicz, 2014), German case-marking (Walter, 2015), Chinese lexical tone (Kowalski, Gordon, & MacWhinney, 2014), English articles (Zhao & MacWhinney, 2018), English prepositions (Wong, Zhao, & MacWhinney, 2018), and repetition fluency (Yoshimura & MacWhinney, 2007). These studies have all sought to test the core claims of the Competition Model regarding the role of cue reliability and cue availability in determining the acquisition of grammatical and lexical patterns. For example, the tutor for French nominal gender focused on the learning of cues such as the presence of final *-isme* as a predictor of masculine gender or the presence of final *-age* as a predictor of feminine gender. In general, we found that, as long as a cue could be formulated in a simple and non-complex way, learning of reliable cues was quite rapid and straightforward. In fact, an hour of practice with the French gender tutor was sufficient to dramatically improve learners ability to mark nominal gender. The English article tutor revealed a similar pattern. Cues such as "lakes are marked with zero article" (as in *Lake Michigan* and not *the Lake Michigan*) are low in complexity and high in reliability. Although these cues are often not high in frequency or applicability, they are nonetheless quickly learned because of their relatively low complexity. In comparison, the cue that requires the definite article for nouns that head relative clauses (as in *the wheel that turns the pump*) is more complex and less reliable. It is a very frequent and applicable cue, but its higher complexity leads to delayed acquisition.

These patterns of relative complexity have their impact on both correctness or accuracy and fluency. Cues that are simple and reliable are learned quickly and produce few errors. Cues that are complex and unreliable lead to lower accuracy. They also present challenges to fluency, because learners are less certain about how to apply these cues. As viewed from the perspective of the CALF model, our e-CALL tutors seek to bolster fluency by improving the accuracy of lexical encodings, including item-based syntactic patterns. Moreover, this framework allows us to understand specific relations between accuracy and fluency. For example, we have demonstrated that imposing a deadline on marking French nouns for gender leads eventually to more robust learning of these assignments.

Conclusion

This analysis has reviewed a variety of ways in which the expanding versions of the Competition Model are beginning to make contact with the work Peter Skehan has stimulated on the trade-offs and the interactions between complexity, accuracy, and fluency. These two lines of research are complementary, both theoretically and methodologically. In theoretical terms, both approaches emphasize the role of resource limitations and the need for proceduralization to achieve fluency. Both approaches recognize a separation between fluency and syntactic complexity on the one hand and accuracy and lexical complexity on the other. The Competition Model references additional constructs regarding the details of item-based processing, syntactic clustering, cue reliability, and cue strength that may prove useful in the development of TBLT models. However, it may be in the area of methodological integration where there are the most obvious possibilities for integration of the two approaches. Work in FluencyBank is attempting to automate many of the same measures that are already being used by the TBLT community. If we could create open-access longitudinal corpora of second language learner data within the framework of SLABank <https://slabank.talkbank.org> and analyze these corpora using FluencyBank measures, we would be able to better understand how learners develop fluency over time and where they face particularly difficult challenges. Hopefully, the future will see increasing cross-fertilization of this type between these two approaches.

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