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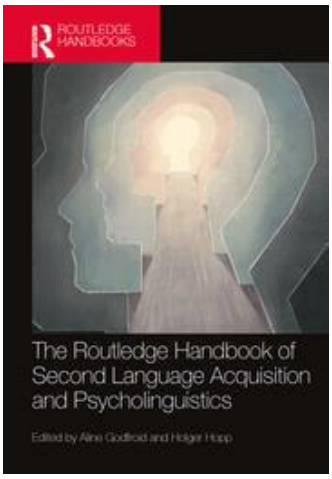


ABSTRACT
This chapter presents an overview of extant research on practice and automatization. Identifying what kind of "practice" is effective for automatization—the gradual and extended learning process—is essential. Automaticity is an advanced stage in acquisition at which knowledge and skills are accurate, quick, efficient, effortless, stable, and unconscious. It intersects with core theoretical constructs in SLA, such as explicit and implicit knowledge and learning as well as the skill acquisition theory and usage-based approach. Research on L2 practice specifically aimed at automatization is reviewed, focusing on five key research streams related to automatization in instructed L2 contexts.

Automatization and Practice

Abstract

Introduction

The concept of automaticity permeates everyday life. We can perform daily routines—such as using a smart phone, typing, walking, and driving a car—very smoothly and efficiently without being consciously aware of the mental processes these activities entail. Using our first language is one of the most automatized skills, as it has been practiced extensively since birth. Yet, automaticity may seem like a far-reaching goal for many second language (L2) learners. In the beginning, L2 learners' speaking performance is far from automatic, as it tends to be inaccurate, slow, halting, and effortful. **As the ultimate goal of L2 learning is to attain automaticity—**characterized as fast, effortless, efficient, and stable language use; hence, understanding automatization, i.e., the gradual and extended learning process leading up to automaticity, is crucial. What is agreed on among most L2 researchers, irrespective of their theoretical standpoints, is the essential role of practice *quantity* for automatizing L2 knowledge and skills. What merits careful deliberation and conceptualization is practice *quality*.

Traditionally, the term "practice" has been associated with mechanical drills and exercises, most notably in Audiolingualism in L2 teaching. Recently, the concept of practice was reconceptualized by DeKeyser (2007) with the aim of integrating applied linguistics and cognitive/educational psychology perspectives. Following this conceptualization, in this chapter, practice is defined as activities involving the use of a L2 repeatedly, systematically, and deliberately for developing knowledge and skills. This broader conceptualization of practice can capture a wide range of L2 practice activities on a continuum from form-focused drills and exercises to meaning-focused tasks, and importantly, many activities that fall in-between (e.g., oral reading, recitation, memorization, dialog reading, skit, picture descriptions, reproduction/retelling). The importance of meaningful and cognitively and emotionally engaging "repetition" is emphasized in the idea of practice aimed at automatization, without unnecessarily reverting to the mindless, repetitive mechanical practice in Audiolingualism.

This new concept of practice has advanced L2 research pertaining to cognitive aspects of L2 learning, including input, interaction, and output practice, along with corrective feedback (DeKeyser, 2007). Suzuki, Nakata, and DeKeyser (2019b) have recently laid out a new research agenda of practice to further stimulate the synergy with cognitive psychology. Just as cognitive psychologists and educational researchers have provided a number of valuable empirical findings over the decades that can serve as useful guidelines for optimizing classroom instruction (e.g., Hattie & Yates, 2013), research on practice from cognitive psychology perspectives can inform L2 classroom teaching and learning (Lightbown, 2019). Practice lies at the intersection of many important L2 theoretical and practical issues—automatization, automaticity, declarative and procedural knowledge, as well as explicit and implicit learning and knowledge (see Textbox 27.1).

TEXTBOX 27.1 Key terms and concepts

1. Automatization: Development of knowledge and skills that afford superior performance both quantitatively (e.g., speed up of underlying processes) and/or qualitatively (e.g., restructuring of processes).

2. Automaticity: An advanced stage in acquisition at which knowledge and skills can be deployed quickly, efficiently, effortlessly, stably, ballistically, and unconsciously.
3. Declarative knowledge: Knowledge of facts, events, lexical items, pedagogical grammatical rules, etc.
4. Procedural knowledge: Knowledge of how to (e.g., how to perform motor actions, calculation, comprehension, and production of language).
5. Practice: Activities that typically involve deliberate and/or systematic repetition aimed at developing L2 knowledge and skills.
6. Knowledge/skill transfer: Applying knowledge and skills that are acquired in one context to another.

Theoretical Perspectives and Approaches

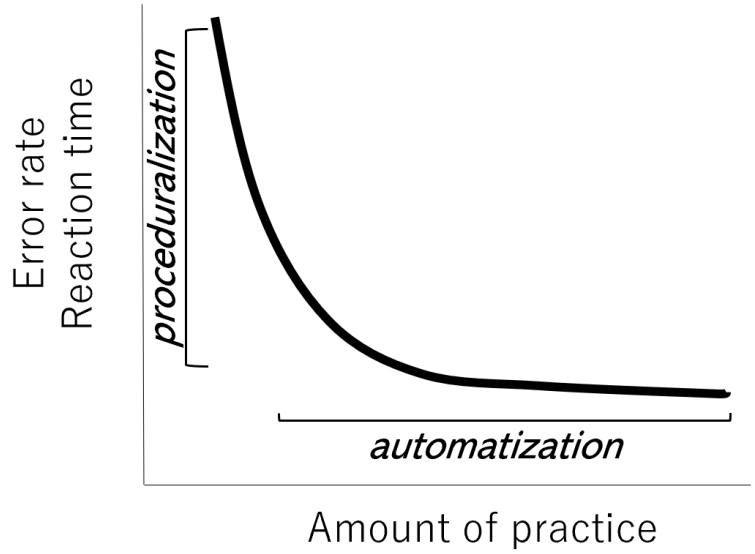
Automaticity is a multi-faceted construct with several distinct features. It allows for elucidating the nature of L2 learning outcomes on a continuum from controlled to automatic processing (Moors, 2016; Moors & De Houwer, 2006). The list is not exhaustive, but automaticity is characterized as fast, efficient, effortless, stable, ballistic (unintentional), and even unconscious (implicit) processing (DeKeyser, 2001; Segalowitz, 2003). These features can covary but should be considered separately, because the presence of one feature (e.g., fast processing) does not necessarily guarantee the presence of others (e.g., unconscious processing). The different roles of these features pertaining to automaticity are rarely discussed in L2 research. Awareness (consciousness) has received focal attention in L2 research and has led to a debate regarding its role in the L2 process and the nature of explicit and implicit L2 knowledge. For instance, researchers investigated the extent to which conscious (explicit) knowledge can be used quickly or automatically (e.g., Dekeyser, 1997; see also Tzelgov, 1997). Perhaps more importantly from theoretical standpoints, it remains to be established whether conscious knowledge that is used quickly (automatized explicit knowledge) can be equated with the fast use of knowledge without awareness (implicit knowledge) (e.g., Godfroid & Kim, 2021; Suzuki & DeKeyser, 2017b; see Isbell & Rogers, 2021 for a recent review).

The nature of L2 grammatical knowledge—explicit and implicit—has been extensively studied, particularly in relation to the central topic of instructed SLA—the role of explicit instruction for the acquisition[1] of grammatical knowledge that can be used for communication (VanPatten & Williams, 2015). Yet, acquisition of implicit grammatical knowledge (without correlates with consciousness) may be of much less concern for L2 teachers, because they are interested in how knowledge that is used accurately and quickly in communication can be attained through L2 instruction and practice, irrespective of its consciousness (e.g., Spada, 2015; Suzuki & Dekeyser, 2017b). This critical view is often overlooked but crucial. The role of explicit instruction is typically explored using outcome measurements involving constrained-response offline tasks that target non-automatized knowledge (e.g., Goo et al., 2015; Norris & Ortega, 2000), which cannot uncover whether and how explicit instruction influences the development of automatized linguistic knowledge used for communication. The construct of automaticity provides a wider variety of criteria—speed, efficiency, stability, and even unconsciousness—for the assessment of L2 knowledge and skills. Automatization also

[1] The terms "acquisition" and "learning" are used interchangeably in this chapter.

offers a useful lens to study L2 learning processes that lead to automaticity, which can be explained in detail based on the skill acquisition theory, originally derived from the Anderson's adaptive control of thought-rational (ACT-R) theory in psychology (Anderson et al., 2004),

Skill acquisition theory (DeKeyser, 2015, 2017) stipulates three stages of development, namely declarative, procedural, and automatization (also see Morgan-Short & Ullman, this volume). Declarative knowledge about L2 (e.g., words, collocations, rules) is typically accessible to awareness and is first acquired by many L2 classroom learners through explicit instruction. Use of declarative knowledge leads to proceduralization—generating target behaviors—resulting in procedural knowledge that can be used for L2 comprehension and production. As procedural knowledge is further fine-tuned for more efficient processing, this long and gradual process culminates in automatization. This learning trajectory is often described as the power law of practice (see DeKeyser, 1997 for empirical data on L2 learning). As illustrated in Figure 27.1, there is an initial rapid improvement in the target skill through practice (proceduralization), and what follows is a very gradual but steady improvement over a number of practice sessions (automatization) (DeKeyser, 2015). This power law curve applies not only to simple tasks (e.g., rolling cigars, typing) but also complex skills like L2 learning, because each subcomponent required for mastering the complex skill obeys the power law (Anderson, 2000).



[Insert Figure 27.1 here]

Figure 27.1 Power Law curve: Proceduralization and automatization.

While skill acquisition theory has been primarily associated with practice, the usage-based approach (N. C. Ellis & Wulff, 2015; Tyler & Ortega, 2018) can also offer complementary insights into the nature of L2 practice. Akin to the skill acquisition perspective, the usage-based approach is based on the premise that frequency is the main driver of L2 acquisition, which "takes tens of thousands of hours of practice, practice that cannot be substituted for by provision of a few declarative rules" (N. C. Ellis, 2002, p. 175). The usage-based approach emphasizes implicit-statistical learning through L2 use for communication in social contexts. Furthermore, the unit of linguistic knowledge is

described as constructions with different levels of abstraction, consisting of single sounds, lexical items, collocations, and abstract rules. Accordingly, automatization occurs at the different levels of construction, as evidenced by an experiment showing that abstract constructions (e.g., resultative construction [Agent−Action−Theme−Result] denoting "X causes Y to Z") can be processed more automatically by more proficient L2 learners (H. Kim & Rah, 2019).

In sum, L2 practice contributes to L2 knowledge and skill development that goes through the declarative−procedural−automatization stages. According to the skill acquisition theory, this process relies primarily on explicit learning (DeKeyser, 2015). Usage-based approach complements this view by emphasizing the implicit/statistical fine-tuning of L2 knowledge from concrete to more abstract constructions (Tyler & Ortega, 2018). Critically, both theories acknowledge the complementary mechanisms of explicit and implicit learning for achieving **automaticity that is the eventual, target outcome of L2 practice.**

Critical Issues and Topics

The chief objective of L2 practice research is to establish what kinds of practice are effective for which learners, for what knowledge and skills, in what contexts and when. Just like other professionals such as music teachers and sports coaches (Carlson, 2003), L2 researchers and instructors have a vested interest in understanding how practice leads to automatization. An overview of key topics and research questions pertaining to L2 practice and automatization is presented in Table 27.1. Clearly, vocabulary or grammar acquisition has been extensively studied, while limited research has been conducted on automatization of pronunciation (M. Li & DeKeyser, 2017, 2019) and pragmatics (S. Li & Taguchi, 2014). Five of the key topics listed in Table 27.1 are discussed in detail in the next section.

[Insert Table 27.1 here]

Table 27.1
Key Topics and Research Questions in Instructed L2 Research on Practice and Automatization

Topics	**Research questions**
Incidental and intentional learning	Does incidental and intentional L2 learning lead to automatization? (e.g., Elgort, 2011; Elgort & Warren, 2014; Hui, 2020)
Role of declarative−explicit knowledge	Does declarative−explicit knowledge facilitate automatization in L2 practice? If so, what type of explicit metalinguistic information is beneficial? (e.g., McManus & Marsden, 2019; Sato & McDonough, 2019)
Practice schedule	What is the optimal practice interval for automatization? (e.g., M. Li & DeKeyser, 2019; Nakata & Elgort, 2020; Suzuki, 2017; Suzuki & DeKeyser, 2017a)
Practice sequence	What is the optimal practice sequence for automatization? (e.g., Suzuki & Sunada, 2019)

Transfer of learning	What kind of practice can maximize the transfer of a practiced skill to other skills used in different contexts? (e.g., De Jong & Perfetti, 2011; M. Li & DeKeyser, 2017; Suzuki, 2021)
Types of corrective feedback	What type of oral corrective feedback is best for promoting automatization? (e.g., Sato & Lyster, 2012)
Timing of corrective feedback	Is immediate corrective feedback more effective than delayed corrective feedback for the acquisition of automatized knowledge? (e.g., S. Li et al., 2016)
Individual differences in automatization	To what extent is the rate of automatization explained by individuals' cognitive abilities? (e.g., Pili-Moss et al., 2020; Suzuki, 2018)

Current Contributions and Research

Vocabulary Learning for Automatization: Speed and Stability of L2 Processing

Automaticity measurements are essential for a better understanding of the automatization process. A variety of psycholinguistic research methods utilizing reaction time (RT) have already been applied to elucidate L2 processing and automatization (see Hamrick, this volume; Jiang, 2011, for an overview). One of those is a representative vocabulary task—a lexical-decision task in which participants judge, as quickly as possible, whether a single word belongs to the target L2 (see Elgort & Warren, this volume). Automatization cannot be simply equated to speeded-up processing (indicated by shorter RT), as it also involves higher processing stability, which is in this case assessed by coefficient of variance (CV), calculated as the ratio of an individual's standard deviation in RT and mean RT. Some researchers argue that CV can capture restructuring or *qualitative* changes in underlying mental processes (e.g., elimination of an inefficient sub-process) rather than *quantitative* changes, i.e., sheer process acceleration (e.g., Segalowitz & Segalowitz, 1993; see also Saling & Phillips, 2007 for neurocognitive underpinnings). Nonetheless, both RT and CV are useful for examining automatization in multiple ways in L2 vocabulary learning (Godfroid, 2019).

The central topic of L2 vocabulary research pertaining to automatization is intentional and incidental learning. In one such investigation, Elgort (2011) asked participants to study 48 novel words intentionally (deliberately) using word cards for one week, after which they were given a primed lexical decision task. The results showed that the studied words led not only to faster access (shorter RT) but also to more stable lexical processing (smaller CV). The lexical-developmental trajectory was further examined in deliberate paired-associate L2 word learning in a laboratory setting by Solovyeva and DeKeyser (2018). Interestingly, their analyses suggested that the CV values followed an inverted U-shaped curve (as opposed to a linear decrease) over the course of training. In the initial learning stage, where new lexical items are integrated in the lexicon, lexical processing becomes less stable (marked by an *increase* in CV), whereas more extensive practice leads to the automatization of existing knowledge (and thus CV decreases).

While intentional, deliberate vocabulary practice is consistently shown to facilitate automatization, research findings on incidental vocabulary learning remain inconclusive. For example, participants in Elgort and Warren's (2014) study, who engaged in incidental vocabulary learning by reading a non-fiction book, did not show any priming effects on the lexical decision task (post-test) despite encountering new

words about 12 times on average (median) in the reading, suggesting an absence of automatization. Similarly, the inverted U-shaped curve of CV values, originally suggested by Solovyeva and DeKeyser (2018), was found only in the intentional condition and not in the incidental learning condition in Hui (2020). The inconsistent results on incidental learning for automatization have also been obtained in studies on L2 collocation (Sonbul & Schmitt, 2013; Toomer & Elgort, 2019).

Perhaps, incidental learning may need to be supplemented by an additional vocabulary instruction to develop more robust lexical knowledge. Elgort et al. (2020) investigated the effects of teaching vocabulary prior to contextual word learning through reading short passages. Their findings indicated that, although the vocabulary pre-teaching was effective in reducing meaning inference errors during reading, post-teaching of word meaning after the reading resulted in better recall and faster lexical processing than pre-teaching. This somewhat surprising finding may suggest that pre-teaching might lower the depth of learning by removing the need for contextual inferences for the novel words while reading. Thus, the learning processes during incidental learning should be explored further in relation to automatization.

The Role of Declarative Knowledge in Grammar Practice for Automatization

The key assumption underpinning the skill acquisition theory is that declarative knowledge is used in proceduralization and further automatization. In laboratory intervention research, McManus and Marsden (2019) trained French L2 learners on *imparfait* verbal morphology through four training sessions delivered across a three-week period. The aim was to establish whether additional provision of L1 explicit information about the target structure, in conjunction with L2 explicit information, facilitated automatization in input-based grammar practice. Analyses of CV derived from RT during input practice showed that L1 explicit information aided automatization in the later, third and fourth training sessions.

On the other hand, Sato and McDonough (2019) conducted a classroom-based study to investigate the role of declarative knowledge in L2 grammar practice for acquiring procedural knowledge of *wh*-questions. Over five weekly sessions, EFL learners engaged in a variety of communicative grammar practice activities (e.g., spot-the-difference task) that obligatorily elicit the use of *wh*-questions. The analyses of speech during the grammar practice showed that prior declarative knowledge, measured by an off-line paper-and-pencil test involving the target structure, allowed the learners to use the target structure accurately in the initial stages of proceduralization. Furthermore, the use of declarative knowledge was also implicated initially for speeding up the use of *wh*-questions in communicative speaking tasks (evidenced by higher a speech rate and shorter pauses). The results yielded by these two studies suggest that deliberate, repeated L2 practice—using declarative knowledge as a crutch—leads to automatization, as evidenced by both global (speech data) and fine-grained (CV) measures. Yet, the optimal integration of declarative knowledge in repeated grammar practice needs to be further explored for a wider variety of linguistic features.

Distributed Practice for Automatization

A large body of cognitive psychology research has been conducted over the last century to identify an optimal schedule for repeated practice (e.g., Cepeda et al., 2006). This age-old question in psychology has recently motivated L2 researchers to investigate

the extent to which L2 acquisition can be enhanced by systematically manipulating practice schedules. In this context, massed, short-spaced, and/or long-spaced practice are compared at different time scales (e.g., less than a day, over days, weeks; see Serrano, 2011 for a comparison at the curriculum level):

- Massed practice: AAAA
- Short-spaced practice: A__A__A__A
- Long-spaced practice: A_____A_____A_____A

One notable finding from the skill acquisition perspective that has emerged from this research stream is that longer spacing seems to facilitate retention of declarative knowledge (e.g., 7-day interval), while shorter spacing (e.g., 1-day interval) tends to be equally or more facilitative for the acquisition of procedural/automatized knowledge (Kasprowicz et al., 2019; M. Li & DeKeyser, 2019; Nakata & Elgort, 2020; Suzuki, 2017; Suzuki & DeKeyser, 2017a). As proceduralization of L2 skills takes longer than the acquisition of declarative knowledge, repeated practice at short intervals or even massed practice may assist in reaching a certain level of proceduralization/automatization that is resistant to skill decay (J. W. Kim et al., 2013). For instance, Suzuki (2017) trained participants on morphological structures in a miniature language over four practice sessions under either shorter-spaced (twice a week) or longer-spaced (once a week) conditions. The participants took an oral, procedural grammar test on the target structures both *before* and *after* each practice session to document the knowledge *losses* and *gains*, respectively. As shown in Figure 27.2, the shorter-spaced practice led to higher retention of procedural knowledge gained in the previous session (i.e., before Session 3 and 4) than the longer-spaced practice. This outcome suggests that shorter-spaced practice allowed learners to engage in repeated practice more efficiently, before experiencing a more pronounced deterioration of existing proceduralized knowledge, to further fine-tune their grammatical knowledge. Given the incipient phase of this research domain, more research from multiple theoretical perspectives is clearly needed for gaining a more comprehensive understanding of this important issue in repeated practice.

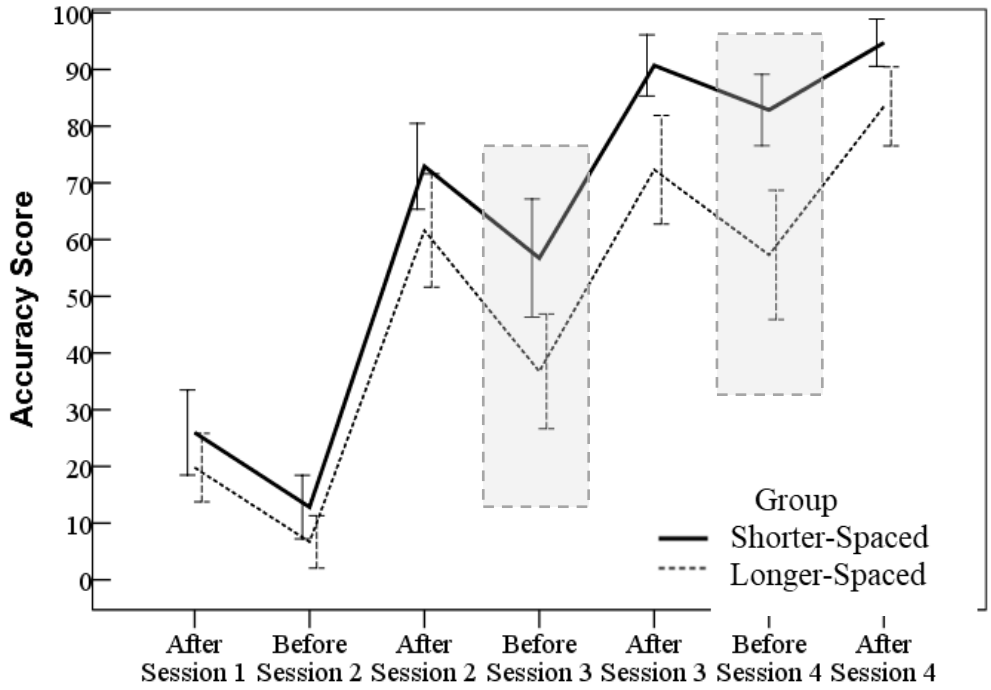


Figure 27.2 Performance changes (losses and gains) over four practice sessions under shorter-spaced and longer-spaced conditions.
Note. The error bars indicate 95% confidence intervals.

Blocked and Interleaved Practice for Automatization

Another issue related to the practice schedule is whether to use blocked or interleaved schedules. In blocked practice, the exemplars are blocked by category, whereas learners are exposed to multiple exemplars from different categories at once in interleaved practice, as illustrated below:

- Blocked practice: AAAA−BBBB−CCCC−DDDD
- Interleaved practice: BACD−DABC−ABDC−CABD

In L2 grammar acquisition, when multiple structures are practiced at once, interleaving seems to be superior to blocking for the acquisition of both declarative knowledge (Nakata & Suzuki, 2019; Pan et al., 2019) and procedural knowledge (Suzuki & Sunada, 2019; Suzuki et al., 2020). Interleaved practice can facilitate the discrimination of similar features that are present, for example, in the English tense systems and relative clause constructions as well as Spanish morphological rules. Furthermore, interleaved practice can potentially lessen the burden on working memory for the proceduralization of English relative clause among EFL learners, because presenting exemplars of similar grammatical structures immediately enhances the comparison of those recently-presented exemplars (Suzuki et al., 2020). Nonetheless, as the benefits of interleaved and blocked practice seem to vary depending on the nature of target materials and skills (Brunmair & Richter, 2019), more research is needed to investigate a variety of linguistic structures not limited to grammar, but also other linguistic domains such as pronunciation and pragmatics (see Carpenter & Mueller, 2013, for the acquisition of highly dissimilar

lexico-phonological rules). Extending the bounds of these linguistic domains, it would also be interesting to elucidate the effects of blocked and interleaved practice on the acquisition of constructions (e.g., "put A in," "put B on," "put D back") from a usage-based perspective (e.g., N. Ellis & Collins, 2009).

Transfer of Learning

Transfer of learning, i.e., acquiring knowledge and skills in one context and applying them to a new context, is the "holy grail" of education (e.g., Haskell, 2001; Singley & Anderson, 1989). An important transfer question in L2 teaching is the extent to which grammar practice in a controlled context (isolated from a meaningful context) can facilitate the acquisition of L2 knowledge that can be used for communication (Tuz, 1993). To address this issue, Spada et al. (2014) compared two versions of form-focused instruction (FFI) approaches in ESL classes: isolated FFI, where target grammar was taught independently from communicative/content-based activities, versus integrated FFI, where the instruction on target grammar was always embedded in communicative activities. Their results showed that, while isolated FFI was more effective for the decontextualized written, *declarative* grammar test, integrated FFI was more beneficial for *automatized* knowledge (measured by an elicited imitation test) that is presumably more useful for communication. However, this finding was not statistically robust and it needs to be further corroborated given its high potential theoretical and pedagogical relevance. Specifically, this pattern fits the prediction of the transfer-appropriate processing model, i.e., the transfer of learning increases when a practice condition has more similarities to the outcome tasks (Lightbown, 2008, 2019). In line with the goal of developing communicative skills, practice needs to involve processes that are similar to actual communication.

From the skill acquisition perspective, it is also important to explore the skill-specific practice effects that occur when a specific skill (e.g., listening) is fine-tuned through practice, making it harder to transfer procedural knowledge gained for that skill to other skills (e.g., speaking). This skill-specific practice effect is empirically supported by a number of L2 studies (e.g., DeKeyser, 1997; M. Li & DeKeyser, 2017; S. Li & Taguchi, 2014; Suzuki & Sunada, 2019) in various practice modalities (reading, writing, listening, speaking) for a variety of linguistic domains (e.g., vocabulary, grammar, pronunciation, and pragmatics). While the aforementioned studies focused on relatively "near" skill transfer, i.e., testing transfer within the same linguistic domain (e.g., comprehension and production of one specific linguistic target), Fukkink et al. (2005) posed an interesting cross-linguistic-domain transfer question. In their EFL classroom intervention study, they examined the extent to which vocabulary item training transfers to reading comprehension of passages containing those trained vocabulary items. Their findings indicated that faster lexical access did not contribute to better reading comprehension. The limited evidence to date suggests that neither "near" nor "far" transfer is robust for procedural knowledge.

Another interesting, and perhaps more pedagogically important, question pertains to how different types of activities and the ways in which these activities are repeated may influence the nature of L2 knowledge and skill development. An interesting perspective can be gleaned from motor and psychology research on practice variability (Schmidt & Bjork, 1992). Kerr and Booth (1978), for instance, demonstrated that variable throwing practice of bean bags (involving multiple targets) resulted in superior

performance on the transfer test relative to constant throwing practice (focusing on the same target). In L2 research, the effects of practice variability were examined for the development of oral fluency, which is tied to underlying L2 proceduralization. In this context, De Jong and Perfetti (2011) conducted an oral fluency training study where English L2 learners in the United States engaged in speech practice in a less variable condition (speech on the same three topics three times [AAA−DDD−GGG]) or the more variable condition (speech on nine different topics [ABCDEFGHI]). The transfer test using a different speech topic showed that only the less variable condition led to meaningful fluency development or proceduralization (e.g., longer mean length of run, shorter pause length, and higher phonation/time ratio).

In Suzuki's (2021) study, EFL learners performed three oral narrative tasks for three consecutive days outside the classroom. The practice variability was manipulated within the day, leading to either a constant (Day 1: AAA, Day 2: BBB, Day 3: CCC) or a variable (Day 1: ABC, Day 2: ABC, Day 3: ABC) condition. These two practice conditions can also be considered as blocked and interleaved practice, respectively (see above). On the transfer test using a different oral narrative task, learners assigned to the constant (blocked) practice showed greater fluency gains (higher articulation rate) than those in the variable (interleaved) practice condition. The evidence yielded by these two studies suggests that constant practice leads to more transfer, which is countered by Kerr and Booth's (1978) findings for motor practice (cf., Wiley & Liu, 2018). The commonality in the practice conditions for superior transfer appears to be the immediate identical repetition within one speaking training session. Repeated practice *en masse* might have helped learners to use and proceduralize the same linguistic constructions, resulting in greater fluency (Suzuki, Eguchi, de Jong, 2022).

What is then the nature of linguistic knowledge that allowed more transfer from the narrowly-focused (constant and blocked) practice? From the skill acquisition perspective, declarative knowledge is general and transferable across many domains/skills, but is not particularly useful due to its inefficiency, whereas procedural knowledge is efficient only for specific processes and is less transferable (Suzuki & Sunada, 2019). Perhaps, procedural knowledge that is automatized at a "not too specific" but "more abstract" level may be useful for promoting transfer (DeKeyser, 2018). For instance, using trigrams with the same combinations of parts of speech (e.g., noun + preposition + noun) seems to enhance L2 utterance fluency (De Jong & Tillman, 2018). These trigrams are considered "constructions" in the usage-based sense, as they represent some abstractness of structures and are neither lexically specific nor too abstract (see Suzuki et al., 2022). The content of procedural knowledge may need further scrutiny to better understand transfer and should be examined from multiple, integrated theoretical perspectives.

Current Trends and Future Directions

The Measurements and Nature of Automatization in L2 Learning

Research on L2 automatization should go hand in hand with the development of automatization measures. Recently, online grammar RT tasks such as sentence construction and maze tasks have been proposed, yet there has been no consensus on the utility of CV in capturing the restructuring of grammatical processing. Some researchers (Hulstijn, Van Gelderen, & Schoonen, 2009) claim that CV may not be useful in this context, because it is difficult to distinguish automatization (smaller RT and CV) from

declarative knowledge accumulation (accuracy improvement). The CV, however, may indicate some restructuring of L2 grammatical processing among those with sufficient immersion experience where L2 can be practiced extensively (Lim & Godfroid, 2015; Suzuki & Sunada, 2018). CV has also started to be utilized in laboratory research on grammar learning (McManus & Marsden, 2019; Pili-Moss et al., 2020; Suzuki, 2018) and its utility needs to be explored further.

Another set of research tools aimed at measuring automatization in grammar processing is strongly linked to the validity issue of explicit and implicit knowledge tests (see Godfroid, this volume). Real-time grammar comprehension tasks such as self-paced reading and word-monitoring tasks (see Jiang, 2011 for details) are arguably tapping into implicit knowledge, i.e., lack of awareness (e.g., Suzuki, 2017; Vafaee et al., 2017; cf., Godfroid & Kim, 2021). These most "implicit" tasks measure grammatical sensitivity to errors of specific grammatical structures during sentence processing rather than processing speed (see Godfroid, 2016 for the application of implicit tests in L2 intervention research). The validity of these measurements is presently being investigated to tackle some outstanding theoretically important questions (see Open Questions and Issues box). These fine-grained measures can complement the data yielded by more global measurements, such as complexity−accuracy−fluency in free production tasks, to better understand the nature of automatization.

The nature of L2 automatization can be further understood by investigating individual difference factors. Laboratory intervention research using semi-artificial languages has just started to uncover the role of individual cognitive abilities in the rate of automatization (Pili-Moss et al., 2020; Suzuki, 2018); however, much less is known about the extent to which aptitudes can predict ultimate attainment, i.e., the near-end state of automatization reached by highly advanced learners in naturalistic settings. A thought-provoking hypothesis was proposed by Doughty (2019), who noted that "for any given person, when motivation is high, personality facets are aligned, and the learning context is excellent, differences in aptitude determine ultimate attainment" (p. 101). **As automaticity is an ultimate goal of L2 skill acquisition,** this assertion should be investigated further by L2 researchers. While it remains to be ascertained whether a relatively innate, stable cognitive ability is necessary for expertise from a psychological perspective (see the special issue in *Intelligence* by Detterman, 2014), further research is needed to establish to what extent cognitive abilities are necessary to achieve automaticity in different aspects of L2 (see, e.g., Suzuki & DeKeyser, 2017b for the role of aptitudes in automatized explicit and implicit grammatical knowledge among advanced naturalistic L2 learners).

Future of L2 Practice in L2 Education

When it comes to the big question of what practice is best suited for automatization, the answer can never be simplistic. A plethora of factors need to be considered, and systematic empirical investigations are essential to enable researchers and practitioners to tailor optimal practice for the learning of a particular linguistic feature for a group of learners with particular characteristics in a given setting. Suzuki et al.(2019a) provided a theoretical framework for examining the complexity of interaction(s) of three key factors (i.e., learner-related, linguistic difficulty and practice) and for better understanding the optimal practice that poses desirable difficulty for learners, which lays the ground for future research (see Textbox 27.2).

L2 research on practice is typically conducted in a laboratory, and/or practice

activities are often decontextualized for the sake of experimental control, despite the broad conceptualization of L2 practice as the ultimate goal of L2 learning (see Introduction of this chapter). This approach has its advantages (e.g., high internal validity), but its shortcomings need to be acknowledged fully to make L2 practice research more relevant for real classroom practice. More attention thus needs to be paid to the quality of L2 practice, and more effort needs to be invested into increasing the ecological validity of L2 practice research while maintaining high internal validity (see Sato & McDonough, 2019 for an illustration).

The growing interest in task-based language teaching offers a promising direction to make L2 practice more meaningful and relevant to real-life L2 use (R. Ellis et al., 2020). From the L2 practice perspective, task repetition research is the most relevant research sub-domain (Bygate, 2018; DeKeyser, 2018). A recent attempt at manipulating the interval of repeated task practice demonstrates the potential intersection across multiple research domains (Bui et al., 2019; Suzuki & Hanzawa, 2021), as well as some of the fluency training studies reviewed above (De Jong & Perfetti, 2011; De Jong & Tillman, 2018; Suzuki, 2021).

Automatization, which can be attained gradually through extended and repeated practice, should be examined in longitudinal studies, ideally in classroom settings. As automatized knowledge is retained better and longer than declarative knowledge, delayed posttests need to be administered to ascertain that some automatized skills do not revert to an earlier stage. In addition to investigating repeated practice using the same set of practice activities, an effective sequence and integration of multiple instruction and practice activities should also be explored (e.g., Kachinske & DeKeyser, 2019). In order to answer the existing and emerging questions outlined in this chapter, automatization must be studied further, as it is an important theoretical construct for understanding the **nature of L2 knowledge development through practice.**

TEXTBOX 27.2 Open Questions and Issues

1. How should a variety of automaticity features be assessed? How does one feature of automaticity (e.g., speed) relate to other criteria (e.g., stability, unawareness, ballistic)?
2. Is there any individual difference factors (e.g., age, cognitive aptitude, motivation) that determine the rate and ultimate level of automatization? If so, which aspects of L2 acquisition are most vulnerable to which individual difference factors?
3. When and how should practice activities be sequenced and repeated to facilitate automatization?
4. What are the practice conditions that promote transfer of learning that facilitates successful L2 use in different situations?
5. How and when should explicit information be integrated with what kinds of activities?

Further Reading

- Jiang, N. (2011). *Conducting reaction time research in second language studies*. New York, NY: Routledge.
  This book presents the nuts and bolts of conducting reaction time research in L2. A variety of methodological options are presented along with a tutorial of the free presentation software, DMDX.

- Suzuki, Y., Nakata, T., & DeKeyser, R. M. (2019). Optimizing second language practice in the classroom: Perspectives from cognitive psychology. *The Modern Language Journal, 103*, 551−561. doi:10.1111/modl.12582
  This introductory paper to the special issue of *The Modern Language Journal* presents an overview of the state-of-the-art empirical research on various practice-related topics.

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