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Chapter 11

Automaticity and Attentional Skill in Fluent Performance

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Fluency—whether of speech, reading, typing, figure skating, or musical performance—often refers to the speed, fluidity, and accuracy of action. For example, a fluent speaker of a second language (L2) is someone who can speak it as quickly as their first language (L1), without hesitation or unnecessary pauses, and free of nonnativelike errors. Second language fluency can, of course, also refer to other aspects of performance (Schmidt 1992). People are considered very fluent in a language if they have an extensive vocabulary, if they can comfortably engage in public speaking, or if they have a sophisticated appreciation of the linguistic subtleties of poetry. Clearly, in ordinary usage the term *fluency* can mean different things at different times, and these different senses may be logically—and psychologically—independent of each other.

This chapter examines fluency in terms of the characteristics of speed, fluidity, and accuracy, characteristics that correspond to psychologically measurable aspects of complex cognitive performance. The following points are made with examples taken from the L2 research literature. First, gains in performance fluency involve qualitative changes in the operation of underlying cognitive processes. Second, such changes are measurable, making it possible to assess the cognitive impact of learning situations designed to improve fluency. Third, the conception of fluency developed here can be applied to other domains of complex performance—music, chess, mathematics, sports, and so on—not only to those involving L2 skill. This

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places fluency within a larger and more general framework for understanding complex performance.

Fluency Gains and Qualitative Changes in Cognitive Functioning

Speed, accuracy, and fluidity (smoothness, freedom from interruptions) correspond to basic, easily measured characteristics of information processing. To understand the psychological factors underlying these characteristics, however, we need to consider how attention and nonattentive processes are involved in the execution of skilled performance. This discussion begins, therefore, by describing the execution of complex cognitive activity, using as examples speaking, reading, and listening in a second language.

Two complementary factors are involved. The first concerns attention. Using a second language involves moment-to-moment decision making in transforming ideas or information represented at one level into representations and actions represented at other levels. For example, when we produce language, we transform ideas represented as thought into speech or writing. Similarly, when we understand language, we again transform information—this time from print or speech sounds into thought. If such transformations are to be carried out in a fluent manner, the mechanisms responsible for them must operate as quickly as possible without loss of information or accuracy. To ensure that the moment-to-moment decisions are accurate, there must be control mechanisms to carry out evaluation and verification. Such control mechanisms are inherently slow, however, and will generally act against the speed and fluidity aspects of fluency. For example, verification may require reexamination of the intermediate products of information processing, resulting (especially in the case of oral skills) in interruptions, false starts, and so on. Nevertheless, such decision-making processes are essential to fluency, since without them, performance would become highly mechanical and insensitive to the demands of changing environmental conditions. Performance would then become susceptible to error.

The second factor complements the first and involves routinizing or rendering automatic those cognitive mechanisms that carry out special functions (Ackerman 1989; Anderson 1983; Schneider, Dumais, and Shiffrin 1984). For example, when reading or listening in L2, fluency can be compromised if there is not rapid, effortless, accurate identification of letter or acoustic patterns. The reader or listener must not become unduly slowed down by the deployment of attention mechanisms at this level. The ability to perform such pattern recognition activities automatically may free up time and attentional resources for purposes that go beyond basic recognition of the physical stimulus. These purposes may include, for example, integrating newly received information with previous knowledge. Also, making processing components automatic may ensure that certain activities are executed efficiently without interference or distraction from other internal sources (Neely 1991; Stanovich 1991). For example, a fluent L2 reader or listener is able to recognize letters or speech sounds without disruption and interference from other ongoing thought processes.

It is important here to distinguish *cognitive fluency* from *performance fluency*. Cognitive fluency refers to the efficiency of the operation of the cognitive mechanisms underlying performance. This efficiency reflects the particular balance that is struck between automatic processing and attention-based processing as already described. A change in cognitive fluency refers to a change in this balance, say, a shift away from reliance on attention-based processes toward greater reliance on automatic processing. Performance fluency, in comparison, refers to the observable speed, fluidity, and accuracy of the original performance that is our focus of interest, for example, as observed in the act of reading, speaking, or listening. Normally we can expect that a significant improvement in performance fluency—for example, an increase in reading speed accompanied by enhanced comprehension after training—will reflect gains that have occurred in cognitive fluency. But this need not always be so. One can imagine improvement in some feature of performance fluency—say, speed—without a change in cognitive fluency, as, for example, when all underlying processes operate more quickly without any accompanying qualitative change in the way automatic and attention-based processes are distributed.

Viewing performance fluency in terms of cognitive fluency poses certain challenges. How can we tell whether one individual is more fluent than another in the cognitive sense just described? For example, can we determine if visual word recognition involves a more optimal blend of automatic and controlled processes in one person than in another? Can we tell whether a particular learning experience has improved performance speed, fluidity, and accuracy because of restructuring (a shift in the balance between attention-based and nonattentive processing) as opposed to a simple speedup or acceleration of the mechanisms underlying performance? Such questions are interesting not only for purposes of theory but for their practical implications. Training that increases performance

fluency by bringing about qualitative changes (restructuring) to underlying cognitive operations may result in wider benefits than might training that improves performance without changes to cognitive fluency. For example, a qualitative change in cognitive fluency may enable a person to perform fluently under a wider variety of situations, such as in noisy contexts or stressful environments.

The next section examines research on cognitive fluency in L2 and its implications for language instruction. Following that is a discussion of the broader implications of this approach to fluency for other areas of performance.

Fluency Gains and Automatic Controlled Processing

In this section, three investigations illustrating the role of automatic and controlled processes in L2 fluency are described. The first asks whether differences in reading fluency among high-level bilinguals can be attributed to differences in the degree to which word recognition had been automatized. The second examines whether higher degrees of fluency in L2 are associated with higher degrees of a specific kind of control mechanism. The third investigation asks whether increasing amounts of L2 experience lead to a change in the blend of automatic and control mechanisms underlying word recognition. Together these studies demonstrate how it is possible to measure differences in the operation of cognitive operations—that is, in the nature of the cognitive fluency—underlying different levels of performance fluency. The results of these studies underscore the important role played by automatic and controlled processes in determining performance fluency. The pedagogical implications of these results are discussed at the end of this section.

The Role of Word Recognition Automaticity in L2 Reading Fluency

Many people are functionally balanced bilinguals in the sense that they possess equivalent speaking, reading, and listening comprehension capabilities in their two languages under ordinary communicative conditions. Despite this high level of skill, the majority of such people usually read more slowly in their L2 than in their L1. Also, if made to listen to artificially accelerated spoken speech, they require a slower rate of presentation in their L2 to achieve the same high level of comprehension as in their L1

(Favreau and Segalowitz 1982). One possible explanation for this is that they generally process information more slowly in their L2. Another possible explanation is that the blend of automatic and control mechanisms is different for first language and second language functioning. For example, word recognition may be less automatic in L2 than in L1. How can it be known which explanation is correct?

This question cannot be investigated by measuring response speed alone. By itself, speed cannot be a valid indicator of either automatic or controlled processing, since any observed speed differences, whether between two individuals or between two performances by a single individual, might be due to particular controlled processes operating faster in one case than the other and not due to differences in automatic processing (or vice versa). Two people may utilize similar blends of automatic and controlled processes for a given task despite differing in their speed of performance. What is needed, therefore, is a test allowing one to distinguish the presence from the absence of automatic processing in word recognition. This has proven possible with an adaptation of a paradigm introduced by Neely (1977). In this paradigm, automatic and controlled processes are sometimes made to act in opposition to each other and at other times in concert. Favreau and Segalowitz (1983) adapted Neely's paradigm in a study that investigated the relative involvement of automatic and controlled mechanisms in word recognition by highly skilled bilinguals.

Favreau and Segalowitz tested two groups of English–French bilinguals. The first—here called the Equal group—consisted of bilinguals able to read texts in their L1 and L2 equally fast while achieving the same high comprehension levels in a subsequent true-false test. The second—here called the Unequal group—consisted of bilinguals who required more time to read texts in their L2 compared to their L1 in order to achieve equally high comprehension levels. The bilinguals were given a primed lexical decision task to perform. In this task, on each trial the subject saw two strings of letters in quick succession. The first was always a lowercase string and is referred to as the "prime." The second was always an upper case string and is referred to as the "target." The prime is so called because of its cognitive "priming" action of setting into motion processes that affect the processing of the target that follows. The subjects' task was to decide whether the target letter string formed a real word (e.g., "APPLE") or not (e.g., "OPPLE"). The prime was either a category name (e.g., "fruit," "furniture") or a meaningless string of zeroes ("00000"). While subjects made no overt response to the prime and were not required to do so, previous research has found that in this type of situation the people will nevertheless read and

comprehend the prime. The evidence for this is that the nature of the prime influences the reaction time to judge the target (Neely 1977). For example, if the prime is semantically related to the target, the response time to judge that the target is a real word may, under appropriate conditions, be faster than if the prime had been unrelated to the target (the prime "fruit" results in faster judgments about "APPLE" than does the prime "00000"). Such effects demonstrate that the subject had indeed read and understood the prime.

In our experiment there were eight different test conditions formed by crossing two conditions of expectancy (Expect Related, Expect Unrelated), two conditions of prime–target time interval (Long, Short), and two language conditions (L1, L2). In the Expect Related condition, subjects were told to expect the target to be semantically related to the prime (e.g., "fruit" to be followed by "APPLE"), and in the Expect Unrelated condition they were told to expect the target to always come from a particular category unrelated to the prime (e.g., "fruit" always to be followed by the name of a piece of furniture). In fact, however, the experiment included a small number of surprise trials in which the target did not conform to expectancy (e.g., "fruit" was sometimes followed by "APPLE" in the Expect Unrelated condition). These surprise trials provided critical data for the analyses. Each of the eight conditions consisted of twenty-eight trials, with four different primes paired with twenty-eight different targets.

There were two prime–target time interval conditions. In the Long Interval condition the interval between the onset of the prime and the onset of the target was 1,150 milliseconds, and in the Short Interval condition it was 200 milliseconds.

Trials in which the prime was the meaningless "00000" provided baseline reaction times. Here the prime was not capable of activating (priming) semantic processing relevant to the target, since "00000" had no meaning. The target was a nonword on half the trials and a real word on the other half, in order to avoid creating a bias to judge the target as word or nonword. Finally, these four conditions were conducted in L1 and in L2, with each subject participating in a total of eight conditions.

Of primary interest here is what happened on surprise trials, that is, when subjects' expectations about the prime–target relation were violated. Consider the L1 Expect Unrelated condition. In the Long Interval condition, both groups showed inhibition effects on surprise trials (e.g., when "fruit" was followed by "APPLE"), that is, *slower* responding compared to baseline trials, even though the target (e.g., "APPLE") was semantically related to the prime (e.g., "fruit"). They also showed facilitation effects, or *faster* responding compared to baseline trials on regular (nonsurprise) trials (e.g., when "fruit" was followed by "CHAIR"), even though the target was not related to the prime. These results were taken to reflect the operation of strategic or controlled expectancy processes activated by the instruction to expect an unrelated target following the prime. These controlled processes operate relatively slowly, but as results showed, the Long Interval condition provided enough time for these processes to affect performance.

Results from the L1 Short Interval condition contrasted with this. Here, subjects showed *facilitation* effects on surprise trials, despite instructions to expect an unrelated target. That is, they were faster to judge that a target like "APPLE" is a real word following the prime "fruit" compared to baseline trials. Presumably, this facilitation was due to the operation of automatic processing that reflected lifelong experience associating category names with semantically related category members. In the Short Interval condition there was not enough time for the control process to exert an influence. Performance therefore reflected the impact of *automatic* activation of the semantically related target by the prime. Here, then, is a dissociation in which there was inhibition in the Long Interval condition but facilitation in the Short Interval condition for similar stimuli. This dissociation convincingly demonstrates automatic processing of the L1 prime in the Short Interval condition, since facilitation occurred despite the subject's effort to prepare for a semantically unrelated target. In other words, word recognition was not only fast but automatic in the sense of being ballistic (once the reading process was triggered, it was unstoppable) and hence immune to interference from other ongoing processes.

The results just described were true for both the Equal and Unequal groups in L1. They provide a reference point for understanding the L2 data.

In the L2 condition the two groups showed similar inhibition effects in the Long Interval condition, indicating similar operation of controlled processes for this task. However, the Equal group showed a significantly larger facilitation effect in the Short Interval condition (ninety-six milliseconds faster than baseline) compared to the Unequal group (only thirteen milliseconds faster than baseline, itself not statistically different from zero). In other words, when the prime–target interval was so short that only automatic processing of the prime could affect a response to the target, an effect was found in L2 with the Equal bilinguals but not with the Unequal bilinguals. Thus members of the Equal group, who were more fluent in L2 reading, were capable of automatic processing of L2 primes, while the less fluent Unequal group subjects were not.

In summary, given enough time (Long Interval condition), responses to targets were affected by subjects' expectations (with faster responses when subjects had expectations confirmed, slower when presented with surprises). When time was short, responses to targets were generally affected by automatized associations between semantically related primes and targets, not by expectations (with faster responses when it was related, slower when it was not). The exception to this was for the Unequal bilinguals in L2; they did *not* respond faster than baseline in the short interval condition, indicating that they lacked the automatized associations that could have affected response time.

These results illustrate an important distinction. While the Equal and Unequal groups differed in their L2 reading fluency, the significant factor was the lack of automatic word recognition in the Unequal group, not reduced speed of processing per se. In fact, the L2 response-time difference between the two groups was only seven milliseconds on baseline trials. Interestingly, the Unequal group actually processed material in their *first* language faster than did the Equal group, although there were no group differences in L1 automaticity (see Segalowitz 1991). It can be seen, therefore, that differences in L2 fluency were associated with differences in the role played by automatic processes (ballistic word recognition), independent of absolute speed of processing.

Controlled Processing in Reading Fluency

Fluent reading, speaking, and listening skills also involve controlled processes. There are many roles for such processes, including integration of information across sentences and with general word knowledge, prediction of upcoming information, or revision of mental representations of already encoded information (Perfetti 1985; Segalowitz, Poulsen, and Komoda 1991). One interesting situation arises from the fact that any given word can have potentially different meanings depending on its context. If people are to correctly understand linguistic messages, they have to focus only on those mental representations that correspond to the appropriate meanings of the words they are receiving. It has been proposed that control mechanisms accomplish this selective focusing through active suppression of mental representations for inappropriate word meanings. For example, in the sentence "He dug with a spade," the word "spade" could evoke a mental representation related to playing cards in addition to a mental picture of a shovel. The sustained elicitation of such inappropriate representations would undoubtedly interfere with fluid comprehension by misleading the reader. An important ability underlying skilled reading, therefore, might be the ability to suppress the activation of such inappropriate representations. Without such selective focusing, readers would find their attentional resources overloaded as they attempt to deal with these inappropriate meanings. (In this discussion, suppression in selective focusing is viewed as a controlled process, consistent with the findings of Gernsbacher and Faust [1995], who reported that suppression is affected by probability of stimulus occurrence, and with those of Tipper, Weaver, and Houghton [1994], who showed that inhibitory processes reflect behavioral goals. However, see Harnishfeger [1995] for discussion of the possible automatic nature of inhibition and suppression.)

Gernsbacher and Faust (1995) discuss a series of studies that supported this idea. They found that skilled (first language) comprehenders were better able to suppress inappropriate representations than less skilled comprehenders, but they were not better in terms of ability to activate contextually appropriate meanings. Neumann, McCloskey, and Felio (1999) reported a study that supported this conclusion in the context of second language skill. Their study used a modified negative priming task (Neill, Valdes, and Terry 1995; Tipper 1985) involving two presentations on each trial. In the first presentation, an uppercase English distractor word and a lowercase English target word appeared on a screen. The subject was to name the lowercase word. Following this, two more words appeared, an uppercase English distractor word and a lowercase target Spanish word or Spanish-like nonword. The subject had to indicate whether the lowercase target was a real Spanish word or not. Sometimes the distractor English word presented in the first pair was the translation of the target Spanish word (this was called the Ignored Repetition condition). Sometimes the target English word named in the first pair was the translation of the target Spanish word (Attended Repetition condition). Finally, sometimes there was no relationship between the English and Spanish words (Unrelated condition). The results indicated that the more advanced bilinguals showed more inhibition in the Ignored Repetition condition (i.e., slower reaction time relative to the Unrelated condition) than did the less experienced bilinguals. The more experienced bilinguals did not, however, show more facilitation in the Attended Repetition condition (i.e., faster reaction times relative to the Unrelated condition) than did the less experienced bilinguals (the tendency, in fact, was toward less facilitation). Thus, what distinguished the more experienced (and presumably more fluent) from the less experienced bilinguals was the amount of *negative* priming or inhibition, not the amount of positive priming. This finding is in keeping

with results summarized in Gernsbacher and Faust 1995 in which higher-level skill in reading (in L1) was associated with superior ability to suppress inappropriate, activated information.

These conclusions may apply to other aspects of L2 functioning. For example, in conversation, fluent interaction will require controlled processing for monitoring the evolving communicative situation—looking for clues in facial expressions, tone of voice, sociolinguistic cues, and the like. This monitoring will require one to suppress inappropriate representations of meaning that are activated by elements of the ongoing situation. Such suppression will allow one to focus on the direction in which the communication is evolving. Poor skill here is likely to affect fluency, since attention will be diverted, thereby reducing processing speed, interrupting fluidity, and compromising accuracy (e.g., misunderstanding what was said, choosing sociolinguistically inappropriate responses, etc.).

Gains in Fluency and Changes in the Blend of Automatic and Controlled Processes

The previous discussion demonstrated how *both* automatic and controlled processes may be implicated in L2 reading fluency. This section considers how it is possible to experimentally identify shifts in the overall balance between automatic and controlled processes without having to actually demonstrate the absence or presence of a specific process as in the 1983 study by Favreau and myself described earlier. This can be accomplished by analyzing response-time variability (for a fuller discussion, see Segalowitz and Segalowitz 1993 and Segalowitz, Segalowitz, and Wood 1998).

Consider what happens as an individual practices a skill in order to gain fluency. In an initial phase, many of the underlying cognitive components will operate inefficiently compared to how they will operate later. At first, performance requires a great deal of attention; the blend of processes underlying performance is heavily weighted in favor of the involvement of controlled processes. For example, in the early phases of language learning, simple pattern recognition and speech organization activities require conscious decision making, verification, and reprocessing before there is comprehension or production. In this initial phase, extended practice may speed up underlying processes, but the overall blend of automatic and controlled processes will remain about the same. Practice leads to faster performance, but overall efficiency remains the same because the underlying organization of processes remains unchanged.

With further training and practice, however, we can expect the performer to reach a second phase, one involving qualitative change or restructuring. In this later phase, some of the more inefficient processes may drop out while processing components concerned with basic pattern recognition or articulatory planning become routinized or automatic, operating more independently of influences from other ongoing cognitive processes. In this phase, performance improves with continued practice, and so does efficiency since the operation of some of the slower, less efficient components will have been eliminated. For example, an English speaker learning to read Russian will at first expend cognitive effort on encoding letters of the Cyrillic alphabet; only later will these letters be encoded as automatically as letters of the English alphabet.

By examining changes in response-time variability it is possible to observe whether performance gains reflect changes in the earlier or later of these two phases. The factor of interest here is the *relative* variability of response time in performance. Relative variability of response time refers to a measure of variability that is adjusted to take into account the absolute size of response time (the measure used in Segalowitz and Segalowitz 1993 is the coefficient of variation, calculated by dividing each person's standard deviation of response time by that person's mean response time). This is useful, since long response times are associated, in general, with larger standard deviations (larger variability) than short response times. When underlying processes become accelerated, as may be expected in the earlier phases of learning, their mean time of operation decreases and standard deviations decrease proportionally (see Segalowitz and Segalowitz 1993). However, the measure of relative variability—standard deviation divided by the mean reaction time—is not reduced, since the change in standard deviation is at most proportional to the change in reaction time.

In contrast, if the cognitive change involves restructuring, then we may also expect the relative variability to decrease with decreases in response time. This is because the faster response time in this case will be due to the dropping out of slower, less efficient components, and not due to a general acceleration of all components. Here the gain in speed is accompanied by a gain in efficiency that comes from reduced involvement of components that are highly variable or "noisy" in their time of operation. Here, relative variability does decrease with decreases in response time.

Analyzing performance changes in this manner leads to interesting hypotheses. First, it may be expected that individual differences in word recognition in the initial phase will be due to differences in the degree of acceleration of the underlying processes, not to restructuring differences. Thus, those initial-phase readers who are relatively fast in word recognition may be expected to have lower standard deviations (less variability) of word-recognition time than the slower readers. This difference, however, should disappear when the standard deviations are converted to measures of *relative* variability of word recognition time, thereby taking into account the absolute value of recognition time. This is exactly what Segalowitz and Segalowitz (1993) found in a lexical decision study of French speakers learning English. Together with Wood, we reported similar results in 1998 for English speakers learning French. This would be an example of increased performance fluency (faster performance) without a change in cognitive fluency.

Second, it may be expected that individual differences in word-recognition speed in later phases of learning will be associated with differences in cognitive fluency, that is, with differences in the nature of the underlying processes. In this case, not only should people who are faster at word recognition show less variability in response time, but their measures of relative variability should be lower (more favorable) than the measures for slower readers in this same phase of development. Indeed, this is what was observed in the two studies just cited; measures of relative variability were lower for faster readers compared to slower readers.

Finally, looking at changes within individuals, it may be expected that as learners gain experience with a language over the course of an academic year, their word-recognition speed will improve due to restructuring of the underlying mechanisms, and this should be reflected in changes in their relative variability of response time. This is what Segalowitz, Segalowitz, and Wood (1998) found. Longitudinal analyses of performance showed that improvements in relative variability paralleled improvements in word-recognition response time; change in learners' relative variability over time correlated significantly with change in their reading speed.

These results demonstrate how fluency gains are associated with measurable changes in relative variability of response time, which in turn can be interpreted in terms of changes in cognitive fluency. The measures employed are useful because they permit a distinction to be made between performance gains that reflect a qualitative cognitive change (restructuring) from those that do not (speedup) without the researcher having to identify specifically which component process was affected.

Pedagogical Implications

The findings reported in the preceding sections of this chapter demonstrate that fluency acquisition involves automatizing some of the component mechanisms underlying performance and that it also involves developing efficient higher-level control mechanisms. In light of this, how can training best enhance performance fluency? Consider automaticity first. Automaticity is promoted when the learner experiences consistent associations between stimuli and cognitive responses to them (Schneider, Dumais, and Shiffrin 1984). Numerous studies involving stimulus recognition have shown that when a given stimulus is encountered only as a target and never as a distractor—a situation known as *consistent mapping*—then recognition becomes automatic according to well-defined criteria of automaticity (Schneider and Fisk 1982; Schneider and Shiffrin 1977; Shiffrin and Schneider 1977). If the same stimulus, however, is also encountered on some trials as a distractor, then practice may lead to faster recognition performance but not to automaticity. The pedagogical implication of this is that developing the automaticity component of fluency requires repetition with consistent associations between stimuli and the learner's cognitive responses to them. How this may be accomplished in second language learning will be discussed shortly.

However, it is worth mentioning here that the audiolingual and pattern drill methods of instruction (Howatt 1984), which are no longer popular, attempted to promote skill through repetition but failed precisely because they did not provide consistent association between words and meanings. They emphasized grammatical accuracy and the structural roles played by words in sentences. The actual exercises devised for these methods kept changing the words used in order to highlight the underlying, abstract structural pattern of interest. As a result, students did not experience a consistent association between word and meaning and therefore did not acquire recognition automaticity.

Less is known about how to promote the efficiency of controlled processes, such as the attention-related suppression discussed earlier. What is known, however, is that, in general, cognitive skills that involve learning are affected by the transfer appropriateness of learning situations. This means that it is important to take into account the similarity between processing that occurs at the time of learning and processing that occurs later when learning is tested or put into practice. If we expect training to promote performance fluency by increasing the efficiency of controlled processing, we probably have to take this factor into account.

According to the theory of transfer-appropriate learning, learning is facilitated when one's cognitive state at the time of test is similar to the cognitive state experienced at the time of learning. Put another way, a learning condition will be transfer appropriate if it activates cognitive

operations that are likely to be reinstated later when the individual attempts to put the learning into practice. This has been demonstrated in a number of important investigations (Blaxton 1989; Roediger 1990; Roediger and Guynn 1996; Tulving 1983). Typically, these have required a person to engage in some particular controlled processing at the time of learning—for example, to focus on the visual rather than semantic properties of words or to think of a word's meaning in a specific way. At the time of test, memory for the learned material is found to be superior when the person is required again to engage in cognitive activities similar to those that were enacted at the time of learning. Performance is diminished, however, when the person is required to enact quite different controlled processes. Such transfer-appropriate learning reflects an important principle of learning and memory—the principle of encoding specificity. According to this principle, the encoding of new information includes a record of the perceptual and cognitive operations that were active at the time of learning (Tulving 1983). As a result, the retrieval path to the target information is enhanced when the representations of the supporting cognitive operations are reinstated.

If training is to promote fluency by enhancing the efficiency of controlled processing, it will need to activate transfer-appropriate cognitive operations during learning. In the case of L2 learning, for example, this could involve operations for processing words, formulaic expressions, and so on in terms of meaning, not just form (Gatbonton and Segalowitz 1988). Such operations are transfer appropriate because people normally engage in meaning-based processing when actually using their L2 in natural contexts. The operations activated during learning should, if they are to be effective, create conditions that psychologically resemble those that will be encountered later. These operations include attention-related suppression and other cognitive processes concerned with the intentional manipulation of meaning.

To summarize, the enhancement of performance fluency in a second language requires a learning situation that promotes cognitive fluency. This will involve transfer-appropriate learning and learning that promotes automaticity. How can this be accomplished in practice? Little L2 learning research directly addresses the issue of fluency in this way. Communicative approaches to language learning (Canale and Swain 1980) appear promising, but their use raises an interesting pedagogical problem. On the one hand, a suitably designed communicative approach can meet the requirements for transfer-appropriate learning so far as it involves the learner in psychologically real communication. On the other hand, to develop automaticity, the learner must engage in extensive repetition, and this is usually accomplished by means of drills and exercises. Such repetition, because of its mechanical nature, risks undermining the transfer appropriateness of the communicative activities. Thus, it would seem that a learning situation cannot both be transfer appropriate and promote automaticity at the same time. This is a challenging problem; however, solutions do exist if one takes into account the psychological demands of the learning and performance environments (see Gatbonton and Segalowitz 1988; Segalowitz and Gatbonton 1995).

Gains in performance fluency can be understood in terms of measurable cognitive change. This makes it possible to test hypotheses about the effectiveness of a given learning situation for promoting fluency. For example, Segalowitz, Watson, and Segalowitz 1995 reported an investigation with a single individual that addressed this issue. The research involved a natural learning activity that included repetition and focus on meaning without drill. The results showed that the learner increased his L2 word-recognition fluency as defined by changes in relative variability of response time in a lexical decision task. He showed cognitive fluency gains with target words encountered in an incidental learning task but not with matched control words. This study demonstrates how it is possible to investigate the role learning conditions play in the acquisition of fluency. It supports the conclusion that a learning context designed to improve visual word-recognition fluency in L2 should include consistent mapping repetition in order to promote automaticity and should require the learner to focus on the meanings of words in order to create conditions for transfer-appropriate learning.

Fluency and Complex Cognitive Performance

The view presented in this chapter is that underlying the linguistic fluency associated with speed, fluidity, and accuracy is a cognitive fluency reflecting a balance between automatic and controlled processing. Obviously, such cognitive fluency is relevant to other skills too, including those as seemingly diverse as performing on a musical instrument, playing hockey, designing a scientific experiment, or cooking a meal. Indeed, a number of theorists have made similar points in their consideration of expertise and skilled action (Ackerman 1988, 1989; Anderson 1983). What is especially interesting is that the question about how people optimize the balance between automatic and controlled processes brings us to a larger, general is-

sue concerning skill, namely, how do successful performers organize their psychological resources to achieve high-level performance. Clearly some people are very good at organizing themselves. They may even appear to have a natural "talent" for performing specific complex cognitive activities fluently (in language, music, mathematics, cooking, etc.) or for benefiting from training aimed at achieving this optimization (see Ericsson and Charness 1994 for a general discussion). Why do some people succeed in this while others fail? One approach to answering this would be to identify separately the automatic and controlled components of a given performance domain and to study how these components develop in successful performers.

It is likely, however, that examining component mechanisms in isolation will be insufficient to achieve a full understanding of how cognitive fluency develops. A person is not just a complex information-processing apparatus with some automatic components and some control mechanisms that need to be individually fine-tuned for optimal performance. Learning cannot be fully understood by studying component processes separately from one another. This follows from the principles of encoding specificity and transfer-appropriate learning. According to those principles, it is the *relationship* between the cognitive demands placed on the learner during and after learning that is extremely important to performance outcome. It matters, therefore, how the learner perceives these cognitive demands (Whittlesea and Dorken 1993).

A better question to ask might be whether successful performers perceive the cognitive demands of a learning situation differently from those who are not so successful. In what ways might people differ in their experience of cognitive demands? Consider the idea that most complex skills are carried out in contexts that are variable and unpredictable. We cannot, for example, predict with absolute certainty everything an interlocutor might say to us, what move a chess opponent might make, or how an unfamiliar piano will respond to our touch. Such skills are sometimes called "open skills" because they are performed under conditions of environmental unpredictability and because they involve performer intentions to produce an effect on the environment (e.g., to persuade the interlocutor, to achieve a particular chess configuration, to create a special sound) rather than to repeat accurately a specific motor or cognitive action (Allard and Starkes 1991). Open skills contrast with "closed skills," for which the performance intention is to reproduce a particular movement or cognitive action, and where environmental variability has minimal relevance for performance (as in typing or simple mental calculations). Clearly, open and closed skill environments place different cognitive demands on the performer. In particular, open skills require attention to situational variability that might disrupt performance. If learners adopt an open-skill stance while learning a complex skill—that is, if they experience the situation as "open" by engaging in the cognitive operations appropriate for handling contextual variability—then learning will be transfer appropriate. But if learners adopt a closed-skill stance while learning, then learning will not be transfer appropriate. For example, learners who approach L2 learning with a closed-skill stance may develop a speaking ability that resembles "reciting" the language but not one suitable for communicating in it under normal conditions. These two stances represent different ways learners may experience their learning contexts. Because this may affect how cognitive restructuring proceeds, these stances may produce different effects on the attainment of fluency (Segalowitz 1997).

A cognitive fluency approach to complex performance has implications for the ideas about talent and human potential. Scheffler (1985) suggests that it is the presence of internal sources of interference, not the lack of some essential characteristic we might call talent or giftedness, that limits the fulfillment of human potential. Internal interference refers to factors within the individual that block efficient execution of the cognitive operations underlying performance. The analysis of fluency provided here is in keeping with Scheffler's approach (and with that of Salthouse 1991). We have seen how the acquisition of performance fluency is associated with the optimization of underlying automatic and controlled processes and how such optimization may be assessed in specific situations. The study of the development of cognitive fluency—whether underlying second language performance or other skill domains—will provide us with a fuller understanding of how people may optimize performance in all areas.

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