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SUMMARY Chapter 2

- Speech perception in infants can be studied by exploiting the fact that babies pay more attention to novel stimuli than to familiar stimuli. This fact is used in the high-amplitude sucking paradigm, the heart-rate paradigm, the preferential looking technique, and the head-turn procedure. All these procedures typically (but not always) consist of an experimental habituation/familiarization phase followed by a test phase.
- Just as adults, infants exhibit categorical perception of speech sounds. This ability appears to be innate, as suggested by the fact that all infants are initially sensitive to the same phoneme boundaries, irrespective of what boundaries exist in the ambient language(s). Categorical perception may also apply to other cognitive domains than language and to other species than humans.
- The ability to perceive nonnative phoneme contrasts declines during the first year of life. This loss of discriminative ability does not affect all nonnative contrasts but depends on specific acoustic and articulatory characteristics of the foreign sounds involved.
- Event-related potentials provide a more sensitive marker of speech perception abilities than the more commonly used behavioral measures. For instance, adult studies have shown that the discrimination of nonnative contrasts which appears to be lost when behavioral measures are employed may turn out to still be intact when ERP measures are used to examine discrimination ability.
- Sequential bilingualism requires the reversal of the decreased sensitivity to nonnative phonetic contrasts. There is some evidence to suggest that training sessions involving natural live adult-infant interactions are more conducive to the restoration of lost nonnative contrasts in 9-10 months olds than mere audio-visual or audio-only training.
- Cross-language distributional overlap of the speech sounds that instantiate particular phonetic categories in a bilingual infant's two languages may delay the emergence of contrastive phonetic categories, possibly because a single extended category for the phonemes of a contrastive pair is first built. This one extended category is subsequently gradually separated into different categories as a result of continued exposure to both languages.
- The adverse effect of cross-language distributional overlap of speech sounds in a bilingual infant's two languages on phonetic discriminative ability can be counteracted by a high frequency of occurrence of the overlapping speech sounds.
- At about 8 months of age infants can recognize recurring syllable sequences in speech and soon thereafter phoneme sequences. This ability provides infants with a means to discover word boundaries in continuous speech and can thus bootstrap vocabulary acquisition The mechanism that presumably underlies this skill is a statistical learning device that is sensitive to sequential probabilities of speech units, both syllables and phonemes.
- At about 9-10 months of age infants growing up in a monolingual environment have had sufficient exposure to the ambient language for statistical learning to

have differentiated between phoneme sequences that occur in their native language and those that do not.

- At about 9-10 months of age infants growing up in a bilingual environment have developed the phonotactics of their dominant language from naturalistic exposure to this language but the phonotactics of their non-dominant language are not quite developed yet. The former finding indicates that growing up bilingual does not inevitably delay the development of language-specific phonotactic knowledge.
- From birth, babies can discriminate between rhythmically different languages (e.g., English and Japanese) but not between rhythmically similar languages (e.g., English and Dutch).
- At 2 months, some infants from monolingual homes can discriminate between their native language on the one hand and foreign languages on the other hand, even if the foreign language has the same rhythm as the native language, whereas others treat a foreign language with the same rhythm as the native language as native. These findings suggest that some 2-months olds have already started to develop detailed segmental knowledge regarding their native language and use it in language discrimination. Others still appear to rely on suprasegmental, prosodic information in discriminating between languages.
- At 4 months, infants from both monolingual and bilingual homes can discriminate between their native language and a rhythmically similar foreign language and infants from bilingual homes can discriminate between their two native languages, even if they share the same rhythm. This suggests that by this time all infants have begun to acquire phonetic knowledge specific to their native language and use it in language discrimination.
- Differential head-turn responses to familiar and unfamiliar words suggest that word-form recognition in monolingual and bilingual infants emerges at 11 months but more sensitive ERP responses to these same words suggest this ability is already present at 10 months in monolinguals and possibly also in bilinguals (the latter possibility has not yet been examined).
- There is some ERP evidence to suggest that the formation of word-meaning connections is somewhat delayed in bilingual-to-be infants as compared with monolingual infants and that this holds in particular for the weaker language of bilingual infants with a relatively low Total Conceptual Vocabulary. Additional behavioral evidence suggests that attending to the phonetic details of words in tasks that require the linking of words to objects develops somewhat more slowly in bilinguals than in monolinguals. Whereas monolingual infants have developed this ability between 14 and 17 months, bilingual infants master it between 17 and 20 months.
- The critical period hypothesis of language acquisition has been examined in three lines of study: (1) Studies examining late first language acquisition in normally hearing children growing up under circumstances of extreme linguistic deprivation; (2) Studies examining late first language acquisition in deaf children born to hearing parents; (3) Studies that examine age of acquisition effects on second language learning.
- Studies examining the critical period hypothesis by scrutinizing the L1 linguistic development of so called “feral” children are compromised by the fact that these individuals were not only deprived of proper linguistic input during the putative critical period but typically suffered other forms of

deprivation as well during the critical years: emotional, social, physical, and nutritional.

- Studies examining the critical period hypothesis by looking at the linguistic development of late L1 learners of sign language are compromised by the fact that relevant preparatory linguistic experience, including the use of an elaborate and sophisticated system of homesign, has plausibly provided these learners with a foundation for later sign language learning. In other words, they did not start first language learning from scratch the moment they gained full access to it.
- Given two groups of equally old late learners of one and the same language, one that has normally acquired language early in life and the second having been deprived of language early in life, ultimate attainment will be substantially higher in the former group than in the latter. This finding supports the "exercise hypothesis" of language learning, which holds that early language experience creates the ability to learn language throughout life and that a lack of language experience early in life compromises the acquisition of any language throughout life.
- Because late second language learning is a far more widespread phenomenon than late first language acquisition, the majority of studies examining age of acquisition effects on language acquisition have tested second language learners varying in acquisition age.
- The "maturational-state" version of the critical period hypothesis holds that early in life humans have a superior capacity for language learning which declines with maturation, even if the language learning capacity is exercised early in life.
- The maturational-state version of the critical period hypothesis predicts two discontinuities in the function that relates the onset age of L2 acquisition to ultimate L2 attainment. The discontinuities result from a temporarily heightened sensitivity to linguistic input early in life that is maximal for some number of years, then gradually decreases, and finally plateaus at some low level.
- A negative correlation between the onset age of L2 acquisition on the one hand and ultimate L2 attainment is consistently obtained across many studies, but contrary to the maturational-state hypothesis no discontinuities can be observed in this age function.
- Contrary to the critical age hypothesis, some late L2 learners attain a native-like proficiency in L2 and some early L2 learners fail to do so.
- Grammatical violations elicit the same pattern of ERP responses (the N400 and P600), and activity in the same brain regions, in proficient L2 speakers and native speakers but different ones in non-fluent L2 users.
- A gradual decline in L2 performance with an increasing age of acquisition beyond early adulthood can be explained in terms of two general-purpose cognitive mechanisms, working memory and declarative memory, which peak in early adulthood but gradually decay afterwards. Because cognitive abilities such as working memory and declarative memory are still underdeveloped in early childhood, the generally superb language learning skills of very young children cannot be explained this way.
- The "less-is-more" hypothesis has been advanced to explain the superior ultimate performance of L2 speakers who started acquiring the language in

early childhood. According to this hypothesis, the superior performance of early learners results from the limited perception and memory skills of very young children. These resource limitations force the child to process the linguistic input in relatively small units and this is assumed to be beneficial for certain aspects of language learning.

- An account of age of acquisition effects in terms of gradually increasing neural commitment can, on its own, explain age effects over the whole age spectrum. It holds that the brain resources of young language learners are still largely uncommitted and can therefore be easily recruited for the learning task. The older the learner, the more neural tissue is already committed to other knowledge and processes and recruiting neurons to subserve new knowledge and tasks becomes increasingly difficult.

SUMMARY Chapter 3

- Learners reach a sufficient level of comprehension in a foreign language when their vocabulary covers 95% of the words in a text or discourse. A basic vocabulary of the 3,000 most frequent word families, equaling 5,000 lexical items, suffices to reach this state.
- Because instruction time in the foreign language classroom is too limited to teach more than a basic vocabulary through direct means, most vocabulary must be learned from context. Yet, to acquire *specific* vocabulary, direct word-focused methods are more effective than context learning.
- Despite being a rather complex procedure for learning foreign vocabulary, the keyword method is effective across many different types of learners, languages, and learning environments. The method is also applicable to other learning materials than foreign vocabulary.
- The keyword method appears more effective with receptive testing of foreign vocabulary than with productive testing and it appears more effective for inexperienced foreign language learners than for experienced learners.
- After only few learning trials per item the vocabulary learned by means of the keyword method is more prone to forgetting than the vocabulary learned by means of other methods (rote rehearsal; context learning). With more practice the various methods result in equal amounts of forgetting.
- Keywords provided by the experimenter or by the learners' peers are more effective than self-generated keywords and pictorial support increases the efficacy of the keyword in, especially, young learners. These findings limit the keyword method's efficacy outside the classroom and laboratory.
- Unlike the common imagery version of the keyword method, its verbiage version is arguably as suitable for experienced foreign language learners as rote rehearsal and uninstructed learning are.
- Foreign language learning gets easier the more experienced the learner is in learning foreign languages. The likely reason is that the learner exploits knowledge already stored in long-term memory.
- Word-word paired associate learning is applicable to all types of words: concrete as well as abstract, cognates as well as noncognates. The keyword method is unsuitable for learning abstract foreign words and for learning words that share a cognate relation with their L1 equivalent.

- Background music affects foreign vocabulary learning in complicated ways, sometimes boosting learning and at other times impeding it, depending upon the type of background music (e.g., vocal or instrumental) and learner characteristics (e.g., their level of baseline brain arousal).
- Foreign language equivalents of concrete L1 words are learned faster and remembered better than the foreign names of abstract words. Some evidence exists that learning the foreign names of words that occur frequently in L1 is easier than learning the foreign names of infrequent L1 words. The likely cause of the concreteness effect is that the representations of concrete L1 words in memory contain more information than those of abstract L1 words. Consequently it is relatively easy to attach the new foreign names to the representation of a concrete L1 words. Arguably the effect of word frequency can be accounted for in a similar way.
- Foreign language words with typical phonotactical forms are acquired faster and retained better than foreign words with atypical forms. The cause of this effect is that learning the sounds of new words involves the operation of phonological short-term memory (the "phonological loop") and the exploitation of phonological information in long-term memory. The phonological loop operates smoothly on typical forms but is impeded when atypical forms are presented for learning. In addition, only typical sound forms can benefit from relevant phonological information in long-term memory.
- Foreign language words that share a cognate relation with the corresponding L1 words are easier to learn and retained better than noncognates. A reason is that the presentation of a word automatically activates similarly formed words in long-term memory, thus facilitating recall. An infelicitous effect of this process is that a word that shares form but not meaning with the input word can be mistaken for the latter's translation.
- Receptive cued recall leads to larger recall scores than productive cued recall. Reasons may be that the, previously known, L1 words are more available than the newly learned L2 words, that comprehension is easier than production, and/or that the L1 words are embedded in a large network of lexical connections whereas the new L2 word is only connected onto its L1 translation.
- Encoding strategies during both first and second language learning shift from a predominant focus on the form aspects of the learning materials to a predominant focus on the meaning aspects. First and second language learning thus seem to involve a similar developmental route.
- The compound, coordinate, and subordinative models of bilingual memory organization differ from one another along two dimensions: the number of underlying conceptual systems that the bilingual possesses (one: compound and subordinative; two: coordinate) and, in the case of a single conceptual system, the way in which this system is accessed when an L2 word is input: directly (compound), or indirectly, via the corresponding L1 word (subordinative).
- It was once thought that compound, coordinate, and subordinative bilingualism result from differed acquisition contexts and that any individual bilingual had memory representations of only of one of these types. The evidence for these assumptions is weak and each bilingual may have memory structures of different types.

- The far majority of translation "equivalent" word pairs consist of words that have language-specific meaning nuances and senses in addition to their shared meaning components. Also, word meaning changes over time and differs between individuals. These facts are better accounted for in terms of distributed models of bilingual memory than in terms of localist models.
- The Revised Hierarchical Model assumes two direct links, of different strengths, between the two word-form representations of a pair of translations, one from the L1 word to the L2 word and one in the reverse direction. In addition, it assumes a single conceptual representation shared by a pair of translations. This shared representation is connected with the L1 form representation by means of a strong link and with the L2 form representation along a weaker link.
- The Revised Hierarchical Model was developed (1) to account for a gradual change from primary reliance on form to primary reliance on meaning with increasing L2 proficiency and (2) to explain differential amounts of meaning activation during processing L1 and L2.
- The Revised Hierarchical Model assumes qualitatively different processes for translating words from L1 to L2 and from L2 to L1. A simpler view is that word translation always involves meaning access ("concept activation"), in addition to a second processing component, word retrieval, and that differential results obtained with L1-to-L2 and L2-to-L1 translation are due to differences in the relative ease with which these two processing components can be executed.
- To reach a high level of proficiency in an L2 the learners' L2 vocabulary must become independent of their L1 vocabulary: L2-specific meaning nuances must be learned, L1-specific nuances must be lost, and knowledge regarding each L2 word's relations with other words in the L2 lexicon must be established. In addition, the access and retrieval of L2 lexical representations must be automated. These goals can never be met by classroom instruction alone but require extensive subsequent reading and/or oral communication in naturalistic L2 environments.
- An explicit instruction to memorize target vocabulary embedded in a larger linguistic context leads to the learning of far more foreign vocabulary than when no such instruction is given but it is not more effective than simply presenting the foreign words to learn with their native-language glosses with the instruction to memorize them. In general, contextual learning by reading texts is a less effective way to learn *specific* vocabulary than out-of-context activities that focus explicitly on this vocabulary.
- The sparse time available for vocabulary teaching in the foreign language classroom can best be spent on a mix of direct teaching of a base vocabulary that covers as large a percentage as possible of the words to be encountered in naturally occurring foreign language texts and discourse, augmented by the teaching of effective skills of how to build vocabulary from context.

SUMMARY Chapter 4

- Unilingual studies on the resolution of lexical ambiguities using behavioral measures have produced mixed results, suggesting that word recognition is neither fully autonomous nor fully interactive under all circumstances but that

the specifics of task and context determine how the ambiguities are resolved. Instead, recent studies employing the ERP methodology, with its high temporal resolution, suggest that word recognition is a highly interactive process, thus providing evidence against a modular view of word recognition.

- In many but not all studies that examined the processing of interlexical homographs and homophones in isolation a homograph/homophone effect was obtained. This indicates that even when words are processed in isolation bilingual word recognition is not always language-nonselective. Specifically, word recognition in the stronger language is language-selective if the activation in the weaker language is not boosted by some experimental manipulation.
- A strong test of language-nonselective bilingual word recognition requires the presentation of exclusively unilingual language materials. Apparent evidence of language-nonselective word recognition in experiments that also present words from the non-target language is inconclusive because these words, however few, will boost the activation level of all representations in the lexicon of the non-target language, thus increasing their availability.
- Language-nonselective lexical access is constrained by the relative dominance of a bilingual's two languages and by context: (1) If the non-target language is the stronger of a bilingual's two languages, lexical access tends to be language-nonselective; if the non-target language is the weaker language of the two, lexical access tends to be language-selective; (2) Immersing the bilingual participants in the non-target language prior to having them perform a word-recognition test increases the degree of activation in the non-target language's memory system and, consequently, of language-nonselective lexical access. Similarly, immersing them in the target language prior to having them perform a word-recognition test increases the degree of activation in the target language's memory system and, consequently, of language-selective lexical access.
- The Bilingual Interactive Activation (BIA) model of bilingual lexical access contains four levels of representation units that represent visual letter features, letters, orthographic word forms, and language information, respectively. Representations at one level can activate and inhibit representations at adjacent levels via excitatory and inhibitory connections. The model assumes language-nonselective lexical access: Activated letter nodes activate word nodes in both of a bilingual's languages.
- BIA explains the interlexical-homograph effects by assuming two word-node representations for interlexical homographs, one for each language, but just one for non-homographic control words. When a homograph is presented to the system both of its word nodes will become activated but when a control word is presented, only its one word node will be activated. The homograph effects are attributed to this difference in the activation state of the recognition system following the presentation of the two types of words.
- In lexical-decision experiments, when interlexical homographs are presented in isolation the size of the homograph effect is especially large when the homograph is more frequent in the non-target language than in the target language. BIA explains this effect by assuming that the memory representations of frequent words have higher baseline levels of activation than those of infrequent words. As a consequence, the memory representations of frequent words have a head start in the recognition process.

- A word stimulus activates both its within-language neighbors and its cross-language neighbors. This result follows directly from BIA's assumption that lexical access is language-nonselective.
- In BIA+ a task/decision system is added onto the word-identification system. This system can explain why the interlexical homograph effect varies across different tasks and with different compositions of the stimulus materials. Whereas the word-identification system is only affected by linguistic sources of information, the task/decision system is sensitive to extra-linguistic influences such as subject expectancies.
- Studies that examined phonological activation in same-alphabet bilingualism have shown that during visual recognition of L2 words bilinguals assemble the phonological forms of these words just as native speakers do, that this process comes about automatically and unconsciously, and that under certain circumstances the grapheme-phoneme conversion rules of both languages are activated in parallel. The few studies that tested different-alphabet bilinguals and bi-dialectal language users suggest these conclusions also apply to these forms of bilingualism.
- Studies that examined the recognition of spoken words using the eye-tracking methodology have shown that the words of weaker L2, but not those of stronger L1, give rise to language-nonselective phonological activation in bilingual lexical memory. Though not totally univocal, the results of gating studies are compatible with these conclusions.
- Generally, the nonnative (L2) lexicon contains fewer lexical elements than the native lexicon. Nevertheless, a spoken nonnative word input causes more spurious activation in a bilingual's nonnative lexicon than the spurious lexical activation caused by this same word if presented to a native speaker.
- Two models of word recognition, SOPHIA and BIMOLA, may ultimately be suitable to explain language-nonselective phonological activation. One salient difference between the two models is that in SOPHIA the lateral inhibition exerted by a word affects words from the same and the other language whereas BIMOLA restricts lateral inhibition to units (phonemes, words) of the other language. Another difference is that SOPHIA but not BIMOLA assumes two language nodes, one for each language.
- Whereas in many tasks cognates are processed faster than matched noncognates, in word naming they are often responded to more slowly. The reason cognates are processed relatively slowly in word naming is that in this task the stimulus must be named aloud. The activated phonological representation of the cognate's translation in the non-target language triggers a response that mismatches the correct response. This pending response will act as a nuisance competitor in the naming process. The consequence is a delayed naming response.
- There is some evidence that in both high-constraint and low-constraint sentence contexts interlexical homograph effects disappear. This suggests that both types of sentence context block co-activation of an interlexical homograph's representation in the non-target language.
- In high-constraint sentence contexts but generally not in low-constraint sentence contexts cognate effects disappear. This suggests that only highly constraining sentence context blocks co-activation of a cognate's representation in the non-target language.

- In general, the modulating effects of sentence context on interlexical-homograph effects and cognate effects indicate that context constrains language-nonselective processing in bilinguals.
- The source of cognate effects on word recognition is equivocal: They may either be due to co-activation of a cognate's translation equivalent in the non-target language, to some representational difference between cognates and noncognates, or to both.
- The most natural interpretation of the observed null-effects of the non-target language in the context studies is that when words are presented in a larger linguistic context the non-target language is deactivated. An alternative interpretation is that also words presented in a larger linguistic context activate lexical representations in both of a bilingual's linguistic subsystems but that the activation in the non-target language's subsystem is ignored by an attention system that supervises performance. This idea is consistent with the recent addition of a control system to models of word recognition.
- When parsing syntactically ambiguous sentences both native speakers and L2 speakers make use of lexical knowledge to resolve the ambiguity. Furthermore, the language the bilingual has recently been exposed to most determines which parsing strategy he adopts in resolving a syntactic ambiguity. Both findings challenge the modular syntax-first model of parsing.
- If an L2 learner's L1 and L2 favor different parsing solutions for a given type of grammatical structure, with increasing L2 proficiency the strategy he employs to parse L2 sentences may change from the strategy he preferably uses while parsing sentences in his L1 to one used preferably by native speakers of his L2.
- When L1 sentences are parsed in an L2 immersion setting, L2 specific-parsing strategies may dominate L1 parsing. When bilinguals parse L2 sentences, L1 lexical knowledge influences the parsing solution that is chosen. Both findings suggest the occurrence of language-nonselective activation of parsing procedures.
- Studies that examined how native speakers and L2 speakers process semantically anomalous sentences indicate that semantic-integration processes are largely similar in native speakers and L2 speakers although they may be delayed and last longer in L2 speakers.
- Studies that examined how native speakers and L2 speakers process syntactically anomalous sentences indicate that syntactic analysis differs qualitatively between native speakers and L2 speakers. Specifically they suggest that initial first-pass parsing is automated in native speakers but not in L2 speakers and that only native speakers execute a repair or reanalysis on a second pass.

SUMMARY Chapter 5

- Models of speech production can be classified in three categories: discrete two-stage models, unidirectional cascade models, and interactive activation models. Discrete two-stage models assume that activation can only flow in forward direction from the lemma level to the lexeme level and that activation is not transmitted from the former to the latter until after one lemma has been selected from the initially activated set of lemmas, the "semantic cohort".

Unidirectional-cascade models also assume that activation only flows forward. In addition they assume that the moment a lemma becomes activated it immediately starts sending activation down to the lexeme level. As a result all elements in the semantic cohort are temporarily phonologically encoded. Finally, as the unidirectional-cascade models the interactive-activation models assume that all initially activated lemmas immediately pass on their activation to the corresponding lexemes. But unlike the unidirectional-cascade models they assume that activation may also flow back from activated lexemes to the corresponding lemmas.

- Any bilingual speech production model should deal with the fact that languages differ in the way they lexicalize the conceptual information in the preverbal message: A particular subset of the preverbal message's conceptual components may be expressed in a single word in one language but may require a whole phrase to be expressed in another language. One solution that has been proposed is to add a so called "verbalizer" to the model, a processing component that receives input from the preverbal message and carves it up in such a way that it matches the semantic information in the targeted lemmas.
- A second issue to explain by any model of bilingual speech production is how the selection of the currently intended language comes about. One way it can do this is by including a piece of information that specifies this intention (a "language cue") in the preverbal message and to include in each lemma a piece of semantic information that specifies to what language it belongs (a "language tag").
- Monolingual and bilingual models of speech production often zoom in on the lexicalization component of the full process, that is, on lexical access. These models usually include three levels of representations, representing preverbal concepts, lemmas, and the words' phonological forms ("lexemes"), respectively. Lemma and lexeme representations can be represented in a single memory node (that is, they can be of the "localist" type) or the information they contain can be spread out over multiple memory nodes ("distributed" or "componential" representations). Multiple lemma activation in models that assume localist lemma representations can be accounted for in terms of spreading activation in a lexical-semantic network.
- Recent speech production models no longer assume that lemma representations contain both semantic and syntactic information but syntactic information only. According to most models of this type activation in the phonological level is mediated by the syntactic information in the lemma. Caramazza's Independent Network Model dismisses lemmas altogether.
- Monolingual picture-word interference experiments have shown that the aural presentation of semantic distracters slows down picture naming but only when the distracter coincides with the picture or precedes it. In addition these studies have shown that aural phonological distracters speed up picture naming but only when the picture is presented first. These semantic interference and phonological facilitation effects are attributed to the convergence of, respectively, semantic and phonological activation in the two types of processes involved in the picture-word interference task: top-down picture naming and bottom-up word processing.
- Bilingual studies using the picture-word interference task have suggested that at some point during picture naming in the weaker L2, the picture's translation in L1 is also activated. This finding indicates that word production in

bilinguals is language-nonselective. It is however not clear whether only lemma selection or both lemma selection and phonological encoding are language-nonselective.

- According to a common view of language-nonselective lexical access in bilingual speech production, strongly activated lexeme representations in the non-response language should hinder production. A couple of bilingual picture-word interference experiments proved this assumption wrong and led to a model of bilingual lexical access in which a stage of language-nonselective activation is followed by a stage of language-specific lexical selection.
- In picture naming by bilinguals a cognate facilitation effect is observed. This effect suggests that phonological encoding is language-nonselective, thus supporting cascaded models of bilingual speech production. The effect may however also result from representational differences between cognates and noncognates.
- Conclusive evidence in support of language-nonselective lexical access in bilinguals requires that the participants in an experiment do not suspect that their bilingualism is being tested and that the stimulus materials are exclusively unilingual. Experiments that employed the bilingual version of the picture-word interference task do not fulfill this requirement.
- Whereas the picture-naming studies legitimate the conclusion that both lexeme activation and phonological encoding are language-nonselective it is too early to tell whether grammatical processing is also language-nonselective.
- Bilingual Stroop studies have reliably produced both intra- and inter-lingual Stroop effects and the size of these effects depended on the participants' relative proficiency in their two languages and on the degree of similarity of the languages. The effects are usually explained in terms of the degree of within- and between-language interconnectedness of the linguistic elements in bilingual memory.
- An analysis of the word-translation task reveals that translating words, Stroop color naming, and naming pictures share many processing components.
- The cognate effect in word translation may be caused by (1) facilitated name retrieval due to language-nonselective phonological encoding that favors cognates over noncognates, (2) representational differences between cognates and noncognates, (3) relatively strong activation of the associated semantic nodes when a cognate is presented for translation.
- Performance in a large number of word-production tasks such as monolingual and bilingual picture naming, monolingual and bilingual Stroop color naming, and word translation is based on activation patterns in one and the same underlying, layered, memory system augmented by a general control system that sees to it that the current goal is met (that is, that the requested task and not another one is performed).
- Word production, visual word recognition, and auditory word recognition may exploit one and the same underlying processing system with components that are either fully shared or highly interconnected between production and recognition and between the aural and visual modality.
- Onset age of L2 acquisition and degree of L2 accentedness are linearly related: The younger the learner when starting to learn the L2 the more native-like his L2 sounds. Despite popular wisdom, for various reasons this age-of-

acquisition effect cannot be explained in terms of a critical age for language learning. A further variable that determines degree of L2 accentedness is the extent to which the L2 speaker still speaks the L1.

- L2 speech accents can partly be explained in terms of the merger of L2 phonetic categories with extant L1 phonetic categories in a phonetic memory system shared by the L1 and L2: L2 sounds that closely resemble an L1 phonetic category in this system assimilate with this L1 category. A second cause of the L2 accent is a process of dissimilation, which applies to L2 sounds that differ strongly from all L1 sounds: It takes a position in phonetic memory which exaggerates the actual physical distance between the new L2 sound and its closest L1 sound.
- The stronger the L1 phonetic categories in memory, the stronger their assimilative and dissimilative effects during L2 speech learning and, consequently, the stronger the L2 accent. The strength of the L1 phonetic categories depends on amount of previous L1 use. Therefore, the older the L2 learner when he started learning the L2 and the more often he still uses the L1, the stronger the L2 accent.
- Accented speech does affect its comprehensibility but this adverse effect is small even in cases where the accent is a strong one.
- Listeners can detect the L1 background of L2 speakers. This is independent evidence of the influence of L1 phonetic categories on the L2 categories.

SUMMARY Chapter 6

- Theories on language control in bilinguals can be distinguished from one another on four interrelated dimensions: the scope of the control process (whether it operates globally, affecting all elements in bilingual memory, or locally, affecting specific elements), the direction in which it operates (proactively or reactively), the locus where it exerts its effect (within the language system or on the output of this system), and the source of the control process (internal or external).
- An experimenter-imposed language switch generally delays processing. One account of this effect assumes two language subsets of which at each moment in time only one is in use. The moment a language switch occurs or is commanded some mental language-switching device sees to it that the mind retreats from one language subset and accesses the other. This operation takes time to execute, thus producing the slowed response
- It has sometimes been assumed that the above “in-out” account of the cost of language switching implies that the linguistic elements in the currently accessed subset are activated whereas those in the subset not in use are deactivated. This assumption does not follow imperatively from the in-out account.
- Language-mode theory is a theory of bilingual language control which assumes that in any communicative context one language is chosen as the base language and that this language is always highly activated. The degree of activation of the other language, the guest language, depends on situational factors such as the person being talked to and the formality and topic of the conversation. The more highly activated the guest language, the more language mixing occurs.

- Various sources of evidence suggest that a bilingual adapts flexibly to the specific characteristics of the current communicative context. In agreement with language-mode theory this evidence of adaptability can be explained in terms of fluctuations in the degree of activation of the bilingual's two language subsets but it may also index fluctuations in the attentiveness of a mental monitor that watches over the output of the language system.
- In Paradis' neurolinguistic model of bilingual language processing language control is secured by activating the targeted items with neural impulses while at the same time raising the activation thresholds of competing items, thereby inhibiting them. This model can account for various forms of bilingual aphasia by assuming that they result from the failure of a control system to set and maintain the activation thresholds of the lexical items in both languages at the appropriate levels while at the same time the language system proper is undamaged.
- Language subsets emerge from the co-occurrence of linguistic elements and the ensuing co-activation of their memory representations, the co-activation creating a bond between these representations. Connectionist models of bilingual language acquisition that exploit this learning mechanism have shown language subsets to emerge even though the input they received was not explicitly marked for language. This suggests that the language membership of linguistic units does not have to be stored in memory explicitly.
- According to the Bilingual Interactive Activation model a word input activates lexical representations of words from both languages. Language control is secured by two language nodes, one for each language, that are activated by input from the corresponding language and then suppress the activation in memory units representing linguistic elements of the other language.
- One way to secure language control in speech production is to add a language cue to the preverbal message and a language tag to the information contained in the lexical entry. This way the preverbal message will activate the representations of words in the targeted response language more highly than those in the other language.
- In the Inhibitory Control Model language control is effectuated, on the one hand, proactively and globally by adapting the activation levels of all lemmas in both language subsets in agreement with the specific language task to perform and, on the other hand, reactively and locally by suppressing the activation in lemmas of words in the non-target language that still threaten to slip through.
- A characteristic effect of reactive suppression is the asymmetrical switch cost: A larger cost when the switch is from a weaker into a stronger language than when it is from a stronger language into a weaker language. However, when trilinguals highly proficient in two languages but less proficient in a third language switch between one of their strong languages and the weaker language the switch costs are symmetrical. This and related findings have led to the suggestion that under certain circumstances bilingual language control exploits a language-specific selection mechanism instead of a reactive inhibitory mechanism.
- Similar results in studies on language switching on the one hand and task switching on the other hand suggest that language switching is a form of task

switching and that the cost of language switching is caused by a resetting operation executed by a general control system.

- Simultaneous interpreting can be decomposed in at least four task components: comprehension, memorizing, production, and coordinating. Presumably the attention-demanding subcomponents of comprehension and production do not take place truly simultaneously but in rapid alternation. This alternation is enabled by anticipatory skills that exploit background knowledge and input redundancy.
- During simultaneous interpreting a mixture of two strategies is used, conceptually mediated translation and transcoding, professional interpreters relying more on the former strategy than student interpreters. Because it involves the automatic triggering of translation-equivalent structures, the transcoding strategy is a useful backup strategy under circumstances of excessive mental load.
- Views on language control in simultaneous interpreting are derived from those that account for language control in unilingual tasks. Control can be effectuated either by the differential proactive activation of language subsets, subcomponents of these subsets, language processing mechanisms, or combinations of these, or by adding a language cue to the conceptual structure that emerges from the linguistic analysis of the source-language input.
- In some ways the comprehension processes of professional translators and amateurs involved in a translation task resemble the comprehension strategies that readers normally use in common unilingual reading. Comprehension processes in translation thus seem to build on those used in normal reading. Still, reading for translation in professional translators modifies normal unilingual comprehension processes.
- As compared to other bilinguals, professional interpreters are relatively fast at executing a number of tasks that tap basic sub-skills of the full interpreting task: retrieving the names for the concepts to express, recognizing words, and assigning meaning to them. In addition, they possess a relatively large working-memory capacity on some tasks resembling simultaneous interpreting in some critical respects. The evidence suggests that these special abilities result from the training of task-relevant linguistic sub-skills in translation and interpreting programs and from extensive on-the-job practice.
- Professional interpreters exploit their relatively large working-memory capacity differently from non-interpreters, as evidenced by their immunity to articulatory suppression on tasks that require them to learn visually presented materials. This suggests that professional interpreters can do without working memory's phonological loop when they process written language material. Because related experiments with aural input *do* show detrimental effects of concurrent articulation on memory, this null-effect of articulatory suppression does not warrant the conclusion that interpreters can also do without the phonological loop when processing spoken source-language input,.
- The relatively large working-memory capacity of professional interpreters is a direct consequence of their fast and, presumably, automatic word-recognition and word-retrieval skills because the more sub-skills run automatically the more mental resources are available for the components of the full interpreting task that defy automation.

SUMMARY Chapter 7

- The multiple languages of a bilingual or multilingual all interact with one another both during acquisition and use. The inevitable consequence of this fact is that the linguistic utterances of bilinguals and multilinguals differ from those of monolingual speakers of the languages involved. In other words, multilingualism does not equal multiple monolingualism.
- The cross-linguistic influence of a multilingual speaker's currently non-selected languages on the currently selected one is determined by a number of factors: the typological distance between the non-selected languages and the selected language; the foreign-language status, strength, and proportion of recent use of the non-selected languages; the order of acquisition of the selected and non-selected languages; the multilingual's current language mode; the speaker's proficiency in the selected language.
- Degree of loss of L2 vocabulary acquired at some point in the past but not used recently depends on the level of L2 proficiency originally attained, the duration of elapsed time since acquisition, the spacing of the training sessions during acquisition, and specific features of the learning materials. Part of the vocabulary originally acquired beyond some minimal threshold level seems to be immune to loss and can still be retrieved from memory after decades of non-use.
- The savings paradigm is a highly sensitive technique to detect residues of seemingly lost knowledge acquired in the remote past. It involves the brief relearning of materials (e.g., a set of L2 words) likely to be known in the past but seemingly lost and the (equally brief) learning of matched materials unlikely to be known before (e.g., another set of L2 words). The test scores on a subsequent cued-recall test for the former materials are typically substantially higher than those for the latter materials even when the test is administered after decades of disuse of the former materials. This finding suggests that prior knowledge is not lost but unavailable and that it takes little to reactivate it.
- The L1 can be completely lost and replaced by an L2 when at a young age the L1 learner is abruptly cut off from further L1 input, as sometimes happens in adoption. Such "catastrophic forgetting", presumably caused by a process of retroactive interference from the L2, has successfully been imitated in computational modeling.
- A comparison of studies on L1 and L2 loss suggests that an L1 that is no longer used is more susceptible to forgetting than an unused L2. However, to legitimately draw this conclusion studies need to be designed that rule out an explanation of the differential loss of L1 and L2 in terms of a number of potentially confounding variables: the amount of continued active and/or passive exposure to the corroded language in between initial learning and later testing; the types of linguistic knowledge that are examined during testing; the originally acquired level of fluency in the corroded language; the test methods used to assess the degree of loss. Only if differential loss is observed for L1 and L2 if these variables have been controlled for it can be concluded that L1 is more easily lost than L2.
- As compared to the speech of monolingual language users, bilingual speech in both L1 and L2 is characterized by an accent in all domains of language: phonology, grammar, and semantics. There are two possible sources of these

accents: memory structures that differ between monolinguals and bilinguals or response competition caused by activated structures in the non-response language in bilinguals.

- Languages differ from one another on many structural dimensions including whether and how they mark grammatical gender, number, and tense. Cross-linguistic studies have shown that the specific linguistic structures encountered by native speakers of a language affect their thought processes and the content of their conceptual structures. Bilingual studies have shown that a switch of language may change bilinguals' processes of thought and that the content of thought in at least some conceptual domains may differ between bilinguals and monolinguals.
- A form of bilingualism called "additive" is advantageous for cognitive functioning. This form of bilingualism emerges when an L2 is added onto the native language instead of gradually replacing it. A form of bilingualism called "subtractive" is detrimental for cognitive functioning. In this form of bilingualism, due to social pressure and educational policy the use of the native language is discouraged and, consequently, it is gradually replaced by L2.
- So called "metalinguistic" tasks appeal to the language user's ability to step back from the meaning-conveying function of language and to reflect on the structural aspects of linguistic expressions. Metalinguistic ability has been analyzed (e.g., Bialystok 2001b) in two component abilities: analysis of representational structures and control of selective attention. It is hypothesized that bilinguals outperform monolinguals on metalinguistic tasks that appeal to the first of these abilities.
- The Simon task is a nonverbal perceptual-motor task that assesses the ability to inhibit or ignore irrelevant spatial information, a skill that requires cognitive control. Bilinguals of all age groups, excepting young adults, outperform matched monolinguals on this task, suggesting superior cognitive control in bilinguals. Furthermore, the adverse effects of aging on cognitive control are smaller in bilinguals than in monolinguals, suggesting that bilingualism attenuates the detrimental effects of aging on cognitive control. These results suggest that bilingualism boosts cognitive control. The absence of a bilingual advantage in young adults is probably due to the fact that at this age cognitive control is at its peak and can not be boosted further by bilingualism.
- The finding that bilingualism brings along superior performance on nonverbal tasks requiring cognitive control suggests that language control in bilinguals exploits more general processes and mechanisms of cognitive control.
- Two forms of cognitive control can be distinguished: (1). The ability to direct attention selectively to specific information in conflict situations while inhibiting or ignoring misleading contextual information; (2). The ability to suppress habitual responses, in other words, to control impulses. Studies that compared monolingual and bilingual children and adults on tests tapping the first of these two types of ability suggest that it is boosted by bilingualism. Studies that compared monolingual and bilingual children on tasks tapping the second ability suggest that it is not affected by bilingualism. In addition, it has been shown that bilingual adults react to alerting signals in the environment more efficiently than monolingual adults.
- There are two ways in which the human control system may safeguard itself against outputting unintended responses: (1) It may directly deactivate

memory nodes associated with non-target responses, thus making these responses less available. (2) It may boost the activation in the memory nodes representing the targeted responses. Through lateral inhibition along inhibitory connections between targeted and non-targeted memory nodes the activation level in the non-target nodes is then lowered, making the associated responses less available.

- Unlike bilinguals mastering two spoken languages ("unimodal" bilinguals), bilinguals who master one spoken- and one sign language ("bimodal" bilinguals) are not better than monolinguals at nonverbal tasks requiring cognitive control. This suggests that the bilingual advantage manifested by unimodal bilinguals does not result from knowing two languages per se but from the fact that these bilinguals are forced to always select one language in speech. This control requirement is less stringent in bimodal bilingualism because the distinct motor systems involved in signing and speaking allow simultaneous production in both modalities.

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