

The Psycholinguistics of the Interaction Approach¹

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Second Language Acquisition (SLA) has been an independent research discipline since the late 1970s, and Sue Gass has been a leading figure throughout its evolution. The first issue of *Studies in Second Language Acquisition* was published in 1978. Sue's PhD thesis 'An investigation of syntactic transfer in adult second language acquisition' was completed in 1979 and published as an article in *Language Learning* in the same year. 'Second language acquisition: An introductory course' (Gass & Selinker, 1994, 2001) is for many *the* standard introductory text. Sue has been associate editor of *SSLA* for longer than I can remember, an active member of the American Association for Applied Linguistics since its inception in 1977 (president in 1987), and is currently the president of the International Association for Applied Linguistics (AILA). Sue's influence can be seen throughout the field. Yet for me, her most profound contribution is her program of research into the Interaction Approach. It was Pitt Corder (1967), a founding father of Applied Linguistics, who famously identified the divorce of input from intake in adult language learning. It was Mike Long in his PhD thesis 'Input,

¹ This chapter is based upon a presentation at AAAL 2007 in the symposium 'Multiple Perspectives on Interaction in SLA' organised by Sue Gass and Alison Mackey. A more visual summary in powerpoint form is available at <http://web.mac.com/ncellis/iWeb/>.

interaction, and second language acquisition' (1980) who proposed that they may be brought back together through Interaction. Sue's work over the last 20 years has persuasively realised the details of this reconciliation (Gass, 1997, 2002, 2003; Gass & Mackey, 2007; Gass, Mackey, & Pica, 1998; Gass & Varonis, 1994; Mackey, 1999; Mackey & Gass, 2006).

There has been a sad but notable coolness too between first and second language acquisition research on and off over this period. Perhaps SLA felt a need to assert its new-found independence. Perhaps child language research and psycholinguistics was too set in its ways, paying little attention to its prior partner. Interaction Approach research within SLA hasn't had a marked impact upon mainstream Psycholinguistics. I believe it should have done. The two fields have independently been recognizing the errors of their old ways and slowly opening up to new influences, expanding their perspectives, and gaining richer understandings as a result. They have so much in common, they really should get back together again.

A marriage counselor might turn to one of the partners at this point and give them uninterrupted time to explain their perspective on things. I believe this is what Alison Mackey and Charlene Polio intended by asking me here to present a psycholinguistic perspective on the need for an interaction approach, and I thank them for the opportunity.

I will begin with associative and cognitive accounts of language acquisition as the learning of form-meaning pairings, and connectionist analyses of how linguistic generalizations emerge from the patterns latent in a learner's usage history. Let me call these foundations Good Old-fashioned Psycholinguistics (GOP) where, in caricature, the learner is an associative network, a mechanistic processor of information, relatively

unembodied, unconscious, monologic, unsituated, asocial, uncultured, and untutored. However incomplete an account, there is much of language and its acquisition that is understandable in these terms. GOP is a necessary, but insufficient, part of the language story. I will outline its utility. The remainder of this chapter will then consider several limitations of GOP, and how these necessitate the introduction of additional factors to a psycholinguistic model of language acquisition. I sketch out what is incremented at each iteration as we take this associative network and imagine it: embodied in human form, perceiving the world accordingly, its cognition bounded by learned attention and its goals necessarily satisfied rather than optimized (Simon, 1957), imbued with consciousness and attentional focus, and dynamically situated in dialogue, its feedback, and the social co-construction of form and meaning. Current child language acquisition research emphasizes how language learning is ‘socially gated’ (Kuhl, 2007) in the same way that Interaction Approach research has persuaded SLA that “conversation is not only a medium of practice; it is also the means by which learning takes place” (Gass 1997, p. 104).

Language acquisition as the learning of Form-function mappings

Saussure (1916) proposed that language comprises linguistic signs, the signifiers of linguistic form and their associated signifieds, the functions, concepts or meanings. In such a view language acquisition is the learning of mappings between form and function, and can be accordingly investigated following domain-general approaches to human learning: *Associative* [the types of learning first analyzed within the Behaviorist Tradition of the 1950s, e.g. for L1 Skinner (1957), for L2 Lado (1964)], *Cognitive* [the wider range of learning processes studied within Cognitive Psychology of the 1970s, including more

conscious, explicit, deductive, or tutored processes, e.g. for L1 Slobin (1992), for L2 McLaughlin (1987), Andersen (1993)], and *Connectionist* [the patterns and associations that emerge from the statistical regularities in the summed experience of form-meaning patterns, as explored in the Parallel Distributed Processing and Competition Model studies of the 1980s and 1990s, e.g. for L1 Elman (1990; Elman et al., 1996), for L2 MacWhinney (1987a; , 1987b), Ellis & Schmidt (1998)]. The inheritors² of these approaches as applied to the domain-specific problem space of languages, are current *Cognitive Linguistic* and *Functional* theories of language [e.g. for L1 Barlow & Kemmer (2000), Croft & Cruise, (2004), Langacker (1987), for L2 Robinson & Ellis (2008b)], particularly Construction Grammar approaches which view language learning as the learning of *constructions* (Bybee, 2007; Croft, 2001; Goldberg, 2003, 2006).

Construction Grammar

Constructions, the basic units of language representation, are form-meaning mappings, conventionalized in the speech community, and entrenched as language knowledge in the learner's mind. They (a) may be complex, as in [Det Noun] or simple, as in [Noun], (b) may represent complex structure above the word level, as in [Adj Noun] or below the word level, as in [NounStem-PL], (c) may be schematic, as in [Det Noun] or specific, as in [the US]. "Morphology", "syntax" and "lexicon" are uniformly represented in construction grammar. Constructions are symbolic: in addition to specifying the utterance's defining morphological, syntactic and lexical form, a construction also

² Some Cognitive Linguists might balk at this attribution of lineage, not because of the roots in structuralist linguistics and in cognitive psychology, but because of the implied degree of resemblance. As in Golding (1955), there's been considerable evolution between ancestor and descendant.

specifies the semantic, pragmatic, and discourse functions that are associated with it. Constructions form a structured inventory (Langacker, 1987) of a speaker's knowledge, usually described in terms of a semantic network, where schematic constructions are abstracted over less schematic ones which are inferred inductively by the speaker in acquisition. Consider the caused motion construction, (e.g. X causes Y to move Z path/loc [Subj V Obj Oblpath/loc]). This construction clearly exists independently of particular verbs, hence the meaning of 'Tom sneezed the paper napkin across the table' is readily intelligible, despite 'sneeze' being usually intransitive (Goldberg, 1995). Although abstract constructions have schematic meaning like this, there is a close relationship between the types of verb that typically appear within them (in this case *put*, *get*, *take*, *push*, etc.), hence the meaning of the construction as a whole is inducible from the lexical items which have been experienced within it.

Constructions are learned from language use, from engaging in communication. *Usage-based theories* of language acquisition hold that an individual's creative linguistic competence emerges from the collaboration of the memories of all of the utterances in their entire history of language use and from the frequency-biased abstraction of regularities within them. *Psycholinguistic* analyses demonstrate that fluent language users are sensitive to the relative probabilities of occurrence of different constructions in the speech stream (Bod, Hay, & Jannedy, 2003; Bybee & Hopper, 2001; N. C. Ellis, 2002a, 2002b; Jurafsky, 2002; Jurafsky & Martin, 2000). Through experience, a learner's perceptual system becomes tuned to expect constructions according to their probability of occurrence in the input.

The Associative and Cognitive Learning of Constructions

The learner's initial noticing of a new word can result in an explicit memory that binds its features into a unitary representation, such as phonological onset-rime sequence 'wʌn' or the orthographic sequence "one". As a result of this, a detector unit for that word is consolidated in the learner's perception system which can subsequently signal the word's presence, or 'fire', whenever its features play out in time in the input. Every detector has a set resting level of activation, and some threshold level which, when exceeded, will cause the detector to fire. When the component features are present in the environment, they send activation to the detector that adds to its resting level, increasing it; if this increase is sufficient to bring the level above threshold, the detector fires. With each firing of the detector, the new resting level is slightly higher than the old one -- the detector is said to be *primed*. This means it will need less activation from the environment in order to reach threshold and fire the next time that feature occurs. Priming events sum to lifespan-practice effects: features that occur frequently acquire chronically high resting levels. Their resting level of activity is heightened by the memory of repeated prior activations. Thus our pattern-recognition units for higher-frequency constructions require less evidence from the sensory data before they reach the threshold necessary for firing.

The same is true for the strength of the mappings from form to interpretation. Each time 'wʌn' is properly interpreted as 'one', the strength of this connection is incremented. Each time 'wʌn' signals 'won', this is tallied too, as are the less frequent occasions when it forewarns of 'wonderland'. Thus the strengths of form-meaning associations are summed over experience. The resultant network of associations, a

semantic network comprising the structured inventory of a speaker's knowledge of their language, is so tuned that the spread of activation upon hearing the formal cue 'w∧n' reflects prior probabilities.

There are many additional factors that qualify this simple picture: The relationship between frequency of usage and activation threshold is not linear but follows the 'power law of practice' whereby the effects of practice are greatest at early stages of learning but eventually reach asymptote. The amount of learning induced from an experience of a form-function association depends upon the salience of the form and the functional importance of the interpretation. The learning of a form-function association is interfered with if the learner already knows another form which cues that interpretation (e.g., Yesterday I walked), or another interpretation for an ambiguous form (e.g. the definite article in English being used for both specific and generic reference). A construction may provide a partial specification of the structure of an utterance and hence an utterance's structure is specified by a number of distinct constructions which must be collectively interpreted. Some cues are much more reliable signals of an interpretation than others. It is not just first-order probabilities that are important, it's sequential ones too, because context qualifies interpretation, with cues combining according to Bayesian probability theory: thus, for example, the interpretation of 'w∧n' in the context 'Alice in w∧n ...' is already clear. And so on.

Yet despite these complexities, psycholinguistic research demonstrates that a theory of language learning requires an understanding of the associative learning of representations that reflect the probabilities of occurrence of form-function mappings. Learners have to figure language out: their task is, in essence, to learn the probability of

an interpretation given a formal cue in a particular context, a mapping from form to meaning conditioned by context. This figuring is achieved, and communication optimized, by learning mechanisms that are sensitive to the *frequency*, *recency*, and *context* of constructions (Christiansen & Chater, 2001; N. C. Ellis, 2002a, 2002b; Elman et al., 1996; MacWhinney, 1999).

Abstraction and generalization

Memorization of previously experienced constructions is just the beginning. Language involves more than the use of formulas, the economic recycling of constructions that have been memorized from prior use (N. C. Ellis, 1996; Pawley & Syder, 1983; Sinclair, 1991). We are not limited to these specifics in our language processing. Some constructions are a little more open in scope, like the slot-and-frame greeting pattern ['Good' + (time-of-day)] which generates examples like 'Good morning', and 'Good afternoon'. Others still are abstract, broad-ranging, and generative, such as the schemata that represent more complex morphological (e.g. [NounStem-PL]), syntactic (e.g. [Adj Noun]), and rhetorical (e.g. situation-> problem -> solution -> evaluation) patterns. Usage-based theories investigate how the acquisition of these productive patterns, generative schema, and other rule-like regularities of language involves generalization from exemplars experienced in usage. The necessary generalization comes from frequency-biased abstraction of regularities: exemplars of similar type (e.g. [plural + 'cat' = 'cat-s'], [plural + 'dog' = 'dog-s'], [plural + 'elephant' = 'elephant-s'], ...) resonate, and from their shared properties emerge schematic constructions [plural + NounStem = NounStem-s]. Thus the systematicities and rule-like processes of language emerge as prototypes or schema, as frequency-tuned conspiracies

of instances, in the same ways as for the other categories by which we come to know the world.

Connectionist models of language acquisition investigate the representations that result when simple associative learning mechanisms are exposed to complex language evidence. Connectionist simulations are data-rich and process-light: massively parallel systems of artificial neurons use simple learning processes to statistically abstract information from masses of input data as generalizations from the stored exemplars. It is important that the input data is representative of learners' usage history, which is why connectionist and other input-influenced research rests heavily upon the proper empirical descriptions of *Corpus Linguistics*. Connectionist simulations show how the default or prototype case emerges as the prominent underlying structural regularity in the whole problem space, and how minority subpatterns of inflection regularity (e.g., [past tense + 'swim' / past tense + 'ring' / past tense + 'bring' /.../ past tense + 'spring' = ?]) also emerge as smaller, less powerful attractors; less powerful because they have fewer friends and many more enemies, yet powerful enough nevertheless to attract friends that are structurally just like them. *Connectionist* approaches to first and second language (Christiansen & Chater, 2001; N. C. Ellis, 1998; Elman et al., 1996; Rumelhart & McClelland, 1986), and *Competition Model* investigations of language learning and processing (Bates & MacWhinney, 1987; MacWhinney, 1987b, 1997), investigate how regularities of form-function mappings emerge from the patterns latent in the summed exemplars of language usage, as sampled and described by *Corpus Linguistics* (Biber, Conrad, & Reppen, 1998; Sampson, 2001; Sinclair, 1991).

In all of these investigations, it is clear that frequency of occurrence is an important causal factor – frequency of form (N. C. Ellis, 2002a), frequency and contingency of mapping (N. C. Ellis, 2006a, 2006b), frequency of co-occurrence (N. C. Ellis, 1996; N. C. Ellis, Frey, & Jalkanen, 2007a, 2007b; N. C. Ellis & Simpson-Vlach, in preparation), and type and token frequency (Bybee & Hopper, 2001; N. C. Ellis, 2002a, in press 2008; N. C. Ellis, Ferreira Junior, & Ke, in preparation; N. C. Ellis, Simpson-Vlach, & Maynard, 2008). The token frequency of instances of a specific construction determines its entrenchment, routinization, and speed of access in language learning and use. The type frequency, the number of different instances which conform to schematic construction, determines its productivity, generalizability, and schematicity. These effects of frequency are clear testament to Usage-based models of language acquisition (N. C. Ellis, 2005b, 2006c). We learn language from using language.

The foundations of GOP are laid. But the language learner in this account is an associative network, a mechanistic processor of information to be exposed to frequency-representative corpora of language. GOP oversimplifies both the learner (as unembodied, unconscious, monologic, autistic, unsituated, uncultured, asocial and untutored) and the mechanisms of the Interaction Approach (Gass, 1997, chapter 5; Gass & Mackey, 2007; Gass & Varonis, 1994; Long, 1996; Mackey, in press-a, in press-b) which holds that what is important in interaction is not simply language usage, but negotiation, with participants' attention being focused on resolving a communication problem and thus “connecting input, internal learner capacities, particularly selective attention, and output in productive ways” (Long, 1996, p. 452). What of the rest? What of meaning,

embodiment, attention, consciousness, dialogue and dialectic, situated, cultured, social and tutored interaction?

Cognitive linguistics, Meaning, and Embodiment

First, the meaning pole of form-meaning associations - what of 'meaning'? While the above GOP-style analyses of the acquisition and processing of linguistic signs explored meaning with atomic representations, using either symbolic representations in artificial intelligence models investigating spreading activation in semantic networks or production systems (Dijkstra & de Smedt, 1996), or localist representations in connectionist models (Christiansen & Chater, 2001), there's clearly a lot more to meaning than that. Cognitive Linguistics (Croft & Cruise, 2004; Langacker, 1987, 2000; Robinson & Ellis, 2008b; Taylor, 2002) provides detailed qualitative analyses of the ways in which language is grounded in our experience and our physical embodiment which represents the world in a very particular way. The meaning of the words of a given language, and how they can be used in combination, depends on the perception and categorization of the real world around us. Since we constantly observe and play an active role in this world, we know a great deal about the entities of which it consists. This experience and familiarity is reflected in the nature of language. Ultimately, everything we know is organized and related to our other knowledge in some meaningful way, and everything we perceive is affected by our perceptual apparatus and our perceptual history.

Language reflects this embodiment and this experience. Consider, for example, the meanings of verbs like *push*, *shove*, *pull*, *hold* and so on, and similar words from other languages. Theoretical understanding of the differences between these words cannot be forthcoming without inclusion of a model of high-level motor control - hand posture,

joint motions, force, aspect and goals are all relevant to these linguistic distinctions (Bailey, 1997; Feldman, 2006; Lakoff & Johnson, 1999). These sensori-motor features are part of our embodiment, they structure our concepts, they play out in time.

Consider too the meanings of spatial language. These are not the simple sum that results from addition of fixed meanings given by prepositions for 'where' an object is, to the meanings of other elements in the sentence describing 'what' is being located. Spatial language understanding is firmly grounded in the visual processing system as it relates to motor action (Coventry & Garrod, 2004; Regier & Carlson, 2002), the multiple constraints relating to object knowledge, dynamic-kinematic routines and functional geometric analyses. Meanings are embodied and dynamic (McRae, Hare, Elman, & Ferretti, 2006; Spivey, 2006); they are flexibly constructed on-line. Meanings like this cannot simply be taught by L2 rules and learned by rote; they can only be learned in situated action.

Embodiment, Interaction, and Speech perception

Next the form pole of form-meaning associations. Linguistic input is embodied too. Speech is spoken by speakers, and we usually perceive it as such, multimodally. The McGurk effect (McGurk & MacDonald, 1976) is a classic demonstration of this perceptual phenomenon: when a video of one phoneme's production is dubbed with a sound-recording of a different phoneme being spoken, the perceived phoneme is often a third, intermediate phoneme. For example, a visual /ga/ combined with a heard /ba/ is often heard as /da/. The effect is very robust; knowledge about it as an illusion seems to have little effect on one's perception of it. Thus speech perception involves information from more than just the acoustic modality.

This applies to language learning too. We do not usually learn language from the airwaves, we learn to comprehend speech as spoken by speakers, and there is considerable research demonstrating that we learn embodied speech in social interaction more easily than we do the acoustic signals of recorded speech.

Firstly, the effects of embodiment on the learning of the signal. Animated embodied speech provides a richer, more learnable signal (for review, Massaro, Cohen, Tabain, Beskow, & Clark, in press). Hardison (2002) found somewhat better learning of /r/ and /l/ by Japanese and Korean speakers when training involved a frontal view of the talker than simply auditory speech. Massaro and Light (2003) evaluated a computer instruction system, Baldi, for teaching non-native phonetic contrasts, by comparing instruction illustrating the internal articulatory processes of the oral cavity versus instruction providing just the normal view of the tutor's face. Eleven Japanese speakers of English as a second language were bimodally trained under both instruction methods to identify and produce American English /r/ and /l/ in a within-subject design. Speech identification and production improved under both training methods and generalization tests showed that this learning transferred to the production of new words. Massaro's work shows that the human face presents visual information during speech production that is critically important for effective communication and learning. While the voice alone is usually adequate for communication between fluent native speakers, visual information from movements of the lips, tongue and jaws enhance the perception of the message for learners, both adults learning a second language and L1 children with severe or profound hearing loss.

Secondly, the additional effects of social interaction. Kuhl, Tsao, and Liu (2003) showed that infants older than 9 months could learn novel phonetic discriminations from exposure to foreign language with contingent social interaction but not from simple language exposure alone. Nine-month-old American infants were exposed to Mandarin Chinese in twelve 25-min live or televised sessions. After exposure, infants in the Mandarin exposure groups and those in the English control groups were tested on a Mandarin phonetic contrast using a head-turn technique. Children in the live exposure group showed phonetic learning whereas those in TV- or audio-only groups did not.

Infant-directed speech (or 'motherese') might assist infants in learning speech sounds because of social scaffolding and the capture of the child's attention by the adult, but also because it exaggerates relevant features and contrasts in the input.

Evidence for the effects of social feedback and interactional synchrony upon the quantity and quality of utterances of young infants comes from Goldstein, King and West (2003). Mothers' responsiveness to their infants' vocalizations was manipulated after a baseline period of normal interaction: Half of the mothers were instructed to respond immediately to their infants' vocalizations by smiling, moving closer to and touching their infants: these were the 'contingent condition' (CC) mothers. The other half of the mothers were 'yoked controls' (YC) in that their reactions were identical, but timed (by the experimenter's instructions) to coincide with vocalizations of infants in the CC group. Infants in the CC group produced more vocalizations than infants in the YC group, and their vocalizations were more mature and adult-like.

There is substantial evidence that motherese provides input that is exaggerated in perceptually relevant ways. Fernald & Kuhl (1987) showed that, when compared to adult-

directed speech, infant-directed speech is slower, has a higher average pitch, and contains exaggerated pitch contours. In a cross-linguistic study, Kuhl et al (1997) performed acoustic analyses of English, Russian and Swedish women when they spoke to another adult or to their young infants to show that vowel sounds (the /i/ in 'see', the /a/ in 'saw' and the /u/ in 'Sue') in infant-directed speech were more clearly articulated. Women from all three countries exaggerated the acoustic components of vowels, 'stretching' the formant frequencies, in infant-directed, as opposed to adult-directed, speech. This acoustic stretching makes the vowels contained in motherese more distinct, and this additional speech clarity in turn aids learner speech discrimination - mothers who stretched their vowels to a greater degree had infants who are better able to hear subtle distinctions in speech (Liu, Kuhl, & Tsao, 2003).

Thus infant-directed speech has three main roles: it attracts attention through higher pitch, it conveys emotional affect, and it conveys language-specific phonological information through vowel hyperarticulation. Recent research shows that Foreigner Directed Speech (FDS), the speech natives direct at non-native learners, likewise promotes speech clarity. Knoll and Uther (2004) compared British English speech directed to first language English learners (infants), and to second language English learners (adult foreigners) as populations with similar linguistic but dissimilar affective needs. Their analyses showed that vowels were equivalently hyperarticulated in infant- and foreigner-directed speech, but that pitch was higher in speech to infants than to foreigners or adult British controls and that positive affect was highest in infant-directed and lowest in foreigner-directed speech. They conclude that there are linguistic modifications in both infant- and foreigner-directed speech that are didactically oriented,

and these linguistic modifications are independent of vocal pitch and affective valence. In a parallel study comparing the acoustics of real and imaginary foreigner-directed speech, Scarborough, Olga, Hall-Lew, Zhao, and Brenier (2007) showed that speakers adjusted their conversational tempo according to the status of their listeners, talking more slowly to foreigners than to native speakers and producing longer vowels. Thus FDS is an acoustically distinct speech style from standard native-directed speech and its adjustments are consistent with those seen in other listener-directed speech styles: Speakers produce a signal that is clearer and easier to process when speaking to listeners who may have had extra processing difficulties due to limited language experience. In these ways the input to the form layer of the associative network is socially gated (Gass, 1997, chapter 3). “Social interaction is *essential* for natural speech learning” (Kuhl, 2007).

Communicating Meaning - Referential Indeterminacy and Intention Reading

Meaning is an essentially individual and private phenomenon; another's cognition and consciousness is internal and unseeable. So how can a language learner come to intuit the meanings and intentions of a conversation partner, thus to determine the mappings between language form and meaning? Even when the learner shares the 'here and now', the same physical context, with an animated and constructive conversation partner, even then, as Quine (1960) demonstrated with his 'gavagai' parable, referential indeterminacy is a fundamental problem. Single words cannot simply be paired with experiences because they confront experience in clusters. Consider a learner of English, child or adult, on a country walk while their conversation partner whispers, 'I wonder if

we'll see some gavagai today.' The learner's reasoning about the meaning of 'gavagai' is likely constrained by the constructions they know, their knowledge of grammatical categories and frames (Brent, 1994; Gleitman, 1990; Maratsos, 1982; Tomasello, 2003), and thus processes of *syntactic bootstrapping* (Gleitman, 1990) might suggest that 'gavagai' is a noun. But what is the referent? They might look up to see across a field an animal hopping close to a ditch..., mushrooms, cowpats, acorns, long grass, thistles ... a rich and complex scene. And just what might 'gavagai' be? Other things being equal, a good bet might be to translate the word as 'rabbit', this search for the correct referent being speeded by various attention-focusing general word learning heuristics: the tendency to believe (1) that new words often apply to whole objects (the whole object constraint), (2) that they more likely refer to things for which a name is not already known (the mutual exclusivity constraint), (3) that they more often relate to things distinguished by shape or function rather than by color or texture, and the like (Bloom, 2000; Golinkoff, 1992; Golinkoff, Mervis, & Hirsh-Pasek, 1994; Gopnik & Meltzoff, 1997; Markman, 1989). These all help. But there is no one clearly correct interpretation, it could be that 'gavagai' actually refers to 'fluffy cotton tail,' or 'long ears,' or 'softness,' or 'undetached rabbit-part,' given that any experience that makes the use of 'rabbit' appropriate also makes these other meanings appropriate too. Referential indeterminacy entails that the learner can only make a guess at the intended meaning. The quality of the guess is determined by the quality of the conversational interaction, the degree to which the conversation partner makes things clear, by pointing, with eyes, gesture or language, and the degree to which speaker and listener negotiate meaning.

Reading the interlocutor's intention in dyadic situated interaction is therefore key in the acquisition of L1. Over the first two years of life, infants develop their capabilities of attention detection (gaze following), attention manipulation (directive pointing), intention understanding (the realization that others are goal-directed), and social coordination with shared intentionality (engaging in joint activities with shared interest, negotiating meanings), and there is considerable current research focusing upon the centrality of these processes in child language acquisition (Tomasello, 1999, 2001; Tomasello, Carpenter, Call, Behne, & Moll, 2005). Traditional GOP took little account that the associative network is gated by social gaze and joint attention (Emery, 2000). However, there are now the beginnings of computational simulations of word learning which examine the influence of inferring interlocutors' referential intentions from their body movements at early stages of lexical acquisition. By testing human participants and comparing their performances in different learning conditions, Chen, Ballard and Aslin (2005) demonstrated that embodied intentions facilitate both word discovery and word-meaning association and present a computational model that can identify the sound patterns of individual words from continuous speech, using nonlinguistic contextual information, and employ eye movements as deictic references to discover word-meaning associations. This is the first model of word learning that not only learns lexical items from raw multisensory signals to closely resemble infant language development from natural environments, but also explores the computational role of social cognitive skills in lexical acquisition

Analyses of classroom, mother-child, and native speaker (NS)-NNS interactions demonstrate how conversation partners scaffold the acquisition of novel vocabulary and

other constructions by focusing attention on perceptual referents or shades of meaning and their corresponding linguistic forms (Baldwin, 1996; Chun, Day, Chenoweth, & Luppescu, 1982; R. Ellis, 2000; Gass, 1997; Gelman, Coley, Rosengren, Hartman, & Pappas, 1998; Long, 1983; Oliver, 1995; Tomasello, 1999; Tomasello & Akhtar, 2000). The interlocutor has various means of making the input more comprehensible: (a) by modifying speech, (b) by providing linguistic and extralinguistic context, (c) by orienting the communication to the “here and now,” and (d) by modifying the interactional structure of the conversation (Long, 1982). Learners search for meanings, and their conversation partners, as language tutors, try to spotlight the relevant alternatives: “Notice this,” they say in their deictic words and actions. Socially scaffolded ‘noticing’ (Schmidt, 1990, 1993, 2001) solves Quine’s (1960) problem of ‘referential indeterminacy.’ In these ways the input to the meaning layer of the associative network is socially gated.

Embodiment, Interaction, and Language Understanding – Construal and Attention

But language does more than select out particular things in the world. Constructions are conventionalized linguistic means for presenting different interpretations or construals of an event. They structure concepts and window attention to aspects of experience through the options specific languages make available to speakers (Talmy, 2000a, 2000b). The different degrees of salience or prominence of elements involved in situations that we wish to describe affect the selection of subject, object, adverbials and other clause arrangement. Figure/ground segregation and perspective taking, processes of vision and attention, are mirrored in language and have systematic relations with

syntactic structure. Thus a theory of language must properly reflect the ways in which human vision and spatial representations are explored, manipulated, cropped and zoomed, and run in time like movies under attentional control. In language production, what we express reflects which parts of an event attract our attention; depending on how we direct our attention, we can select and highlight different aspects of the frame, thus arriving at different linguistic expressions. The prominence of particular aspects of the scene and the perspective of the internal observer (i.e. the attentional focus of the speaker and the intended attentional focus of the listener) are key elements in determining regularities of association between elements of visuo-spatial experience and elements of phonological form. In language comprehension, abstract linguistic constructions (like simple locatives, datives, and passives) serve as a “zoom lens” for the listener, guiding their attention to a particular perspective on a scene while backgrounding other aspects (Croft, 2001; Croft & Cruise, 2004; Langacker, 1987, 1999; Taylor, 2002).

Embodiment and social interaction is crucial to the learner’s realization of the intended construals of situations, and hence of the proper interpretations of linguistic signs. In a speech situation, a hearer may attend to the linguistic expression produced by a speaker, to the conceptual content represented by that expression, and to the context at hand. But not all of this material appears uniformly in the foreground of the hearer's attention. Rather, various portions or aspects of the expression, content, and context have different degrees of salience. Such differences are only partly due to any intrinsically greater interest of certain elements over others. More fundamentally, language has an extensive system that assigns different degrees of salience to the parts of an expression, reference, or context. Talmy (2000a, b) analyses how the *Attentional System of Language*

includes some fifty basic factors, its "building blocks". Each factor involves a particular linguistic mechanism that increases or decreases attention on a certain type of linguistic entity. Learning a language involves the learning of these various these attention-directing mechanisms of language, and this, in turn, rests upon L1 learners' developing attentional systems and L2 learners' attentional biases.

Cross-linguistic research shows how different languages lead speakers to prioritize different aspects of events in narrative discourse (Berman & Slobin, 1994). Because languages achieve these attention-directing outcomes in different ways, such cross-linguistic differences must affect L2 learning, making it easier where languages use them in the same way, and more difficult when they use them differently. To the extent that the constructions in L2 are similar to those of L1, L1 constructions can serve as the basis for the L2 constructions, but, because even similar constructions across languages differ in detail, the acquisition of the L2 pattern in all its detail is hindered by the L1 pattern (Odlin, 1989; Robinson & Ellis, 2008b).

Languages lead their speakers to experience different 'thinking for speaking' and thus to construe experience in different ways (Slobin, 1996). Learning another language involves learning how to construe the world like natives of the L2, 'rethinking for speaking' (Robinson & Ellis, 2008a). Thus Cognitive Linguistics emphasizes how language is learned from participatory experience of processing language during embodied interaction in social contexts where individually desired non-linguistic outcomes (e.g, a cup of tea) are goals to be achieved by communicating intentions, concepts and meaning with others. An understanding of participation in situated action is thus essential to the understanding of meaning and the acquisition of linguistic

constructions in L1 and L2. Nobody can really understand the meaning of a British ‘cup of tea’ without going through the ritual.

Attention affects our understanding and construal of situations. Conceptual relevance determines the salience of events and their features. Language can bring particular elements into attentional focus and background others. We do not perceive the world, we perceive an attended subset of it. The intake is far less than the available input (Corder, 1973; Gass, 1997), and this is true both for the form layer of the associative network and for the meaning layer. The inputs to our associative networks are attentionally-gated, and what is attended is negotiated in the dynamics of conversational interaction.

Learned attention, Interference, and Transfer

Associative learning provides the rational mechanisms for first language acquisition from input-analysis and usage (N. C. Ellis, 2006a), allowing just about every human being to acquire fluency in their native tongue. Yet although second language learners too are surrounded by language, the level of ultimate attainment for even the most diligent L2 learner is usually considerably below what a child L1 acquirer achieves, with some naturalistic L2 acquirers only acquiring a “Basic Variety” characterized by pragmatic word order and minimal morphology (Klein & Purdue, 1992). In this Basic Variety, most lexical items stem from the target language, but they are uninflected. “There is no functional morphology. By far most lexical items correspond to nouns, verbs and adverbs; closed-class items, in particular determiners, subordinating elements, and prepositions, are rare, if present at all.” “Note that there is no functional inflection whatsoever: no tense, no aspect, no mood, no agreement, no casemarking, no gender assignment” (Klein, 1998, pp. 544-545).

Associative learning underpins these difficulties. The Rescorla-Wagner (1972) model, a formula summarizing the results of thousands of psychological investigations of animal and human learning, states that the amount of learning induced from an experience of a cue-outcome association depends crucially upon the salience of the cue and the importance of the outcome. Low salience cues are poorly learned.

The more frequent words tend to be the shortest ones in the language. Zipf (1949) summarized this in the *principle of least effort* – speakers want to minimize articulatory effort and hence encourage brevity and phonological reduction. And it is the grammatical functors, the closed class words, that are most frequent words of the language. The top twenty most frequent words of English are *the, of, and, a, in, to, it, is, to, was, I, for, that, you, he, be, with, on, by, at* (Leech, Rayson, & Wilson, 2001). More than half of English spontaneous speech consists of functors such as these. These are the “little words” of the language which because of their high frequency of usage have become phonologically eroded and homonymous. The low salience of grammatical functors, the low contingency of their form-function mappings, and adult acquirers’ learned attentional biases and L1-tuned automatized processing of language, results in their not being implicitly learned by many naturalistic learners whose attentional focus is on communication (N. C. Ellis, 2006a, 2006b, 2007b, 2008a, 2008b). The form input to the associative network is attentionally gated, and it fails to acquire these grammatical functors because of their low salience.

Exploiting Attentional Gating - Form-Focused SLA

But the attentional gates of the network can also be manipulated. Interactional or pedagogical reactions to non-nativelike utterances can serve as dialectic forces to pull

SLA beyond the Basic Variety. When an interaction-partner or instructor intentionally brings additional evidence to the attention of the learner by some means of *form-focussed instruction* (Doughty & Williams, 1998; Spada, 1997) or consciousness raising (Sharwood Smith, 1981), this can help the learner to ‘notice’ relevant aspects of linguistic form or form-function mapping (Schmidt, 2001). Terrell (1991) characterized explicit grammar instruction as the use of instructional strategies to draw the students’ attention to, or focus on, form and/or structure, with instruction targeted at increasing the salience of inflections and other commonly ignored features by firstly pointing them out and explaining their structure, and secondly by providing meaningful input that contains many instances of the same grammatical meaning-form relationship. ‘Processing Instruction’ (Van Patten, 1996) similarly aims to alter learners’ default processing strategies, to change the ways in which they attend to input data, thus to maximize the amount of intake of data to occur in L2 acquisition. SLA can thus be freed from the bounds of L1-induced selective attention by some means of Focus on Form that is socially provided (Gass, 1997, 2002, 2003; Gass & Mackey, 2007; Lantolf & Thorne, 2006; Long, 1991; Pica, 1988, 1994) and that recruits the learner’s explicit conscious processing. Form-focused instruction like this does result in more accurate SLA. Reviews of the experimental and quasi-experimental investigations into the effectiveness of explicit learning and L2 instruction (N. C. Ellis, 2005a; N. C. Ellis & Laporte, 1997; Spada, 1997), particularly the comprehensive meta-analysis of Norris & Ortega (2000) that summarized the findings from 49 unique sample experimental and quasi-experimental investigations into the effectiveness of L2 instruction, demonstrate that form-focused L2 instruction results in large target-oriented gains, that explicit types of

instruction are more effective than implicit types, and that the effectiveness of L2 instruction is durable.

Consciousness and Learning

Form-focused instruction pulls learners out of their implicit habits, their automatized routines, by recruiting consciousness. Habits are implicitly controlled attractor states. We never think of walking, until it breaks down; as we start to stumble then the feeling of falling is the negative evidence that recruits conscious control. We rarely think about driving, until it breaks down; as the clutch grinds, or the child runs into the road, these are the times when we become aware of the need to escape automatized routines. “The more novelty we encounter, the more conscious involvement is needed for successful learning and problem-solving” (Baars, 1997a). So for language too: At each point in our history of language usage, the sample of language to which we have been exposed serves as the database from which we have induced our current model of how language operates – our *modus operandi* is based on estimates of the workings of the whole that we have determined from analysis of our sample of usage (N. C. Ellis, in press 2008). We operate according to these hypotheses until we receive negative evidence that we have erred in our analysis. Our consciousness is raised and the tension between our implicitly controlled system and the evidence of overgeneralization to which we have been made aware serves as the interface allowing system change (N. C. Ellis, 2005a).

What is elected to consciousness affects learning. Consciousness is the publicity organ of the brain. It is a facility for accessing, disseminating, and exchanging information and for exercising global coordination and control: Consciousness is the interface (N. C. Ellis, 2005a). “Paying attention—becoming conscious of some

material—seems to be the sovereign remedy for learning anything, applicable to many very different kinds of information. It is the universal solvent of the mind” (Baars, 1997b, section 5). Learning is dynamic; it takes place during processing, as Hebb (1949), Craik and Lockhart (1972), Pienemann (1998), and O’Grady (2003) have all reminded us from their neural, cognitive, and linguistic perspectives. There are different forms of language learning, broadly, the implicit tallying and chunking that take place during usage (N. C. Ellis, 2002a, 2002b) and the explicit learning in the classroom and that follows communication breakdown (N. C. Ellis, 2005a, sections 3-4). Implicit learning from usage occurs largely within modality and involves the priming or chunking of representations or routines within a module, with abstract schema and constructions emerging from the conspiracy of memorized instances. It is the means of tuning our zombie agents, the menagerie of specialized sensori-motor processors that carry out routine operations in the absence of direct conscious sensation or control. It is largely automatized. It operates in parallel. In contrast, conscious processing is spread wide over the brain and unifies otherwise disparate areas in a synchronized focus of activity. Conscious activity affords much more scope for focused long-range association and influence than does implicit learning. It brings about a whole new level of potential associations. It operates serially.

Consciousness too is dynamic; it is perhaps the prototype example of an emergent phenomenon: the stream of consciousness is one of every-changing states, each cued by prior state and perceptual context, the units of consciousness being identifiable as patterns of brain synchrony in time. The dynamics of language learning are inextricably

linked to the dynamics of consciousness, in neural activity and in the social world as well. Input to the associative network is gated by consciousness.

Dialogue and Dialectics

Language use and consciousness are both socially emergent too. Language use, social roles, language learning, and conscious experience are all socially situated, negotiated, scaffolded, and guided. They emerge in the dynamic play of social intercourse. Our expectations, systematized and automatized by prior experience, provide the thesis, our model of language, and we speak accordingly. If intelligibly and appropriately done, we get one type of social reaction, and conversation focuses further on the intended message, meaning and communication. If not, we may get another type of social reaction that helpfully focuses our attention on what we do not yet know how to do (Gass, 1997, 2002, 2003; Gass & Mackey, 2007; Long, 1982; Mackey, in press-a, in press-b). Through the provision of negative feedback, be it a clarification request or possibly a recast, some dialectic, an antithesis which contradicts or negates our thesis, our model of language, and the tension between the two, being resolved by means of synthesis, promotes the development of our language resources.

The usual social-interactional or pedagogical reactions to non-nativelike utterances involve an interaction-partner or instructor bringing additional evidence to the attention of the learner by some clarification request, or negative feedback, or correction, or focus-on-form, or explicit instruction, recruiting consciousness to overcome the implicit routines that are non-optimal for L2 (N. C. Ellis, 2005a; Gass, 1997, chapters 5 & 6). Learning is ever thus. It takes place in a social context, involving action, reaction, collaborative interaction, intersubjectivity, and mutually assisted performance (Donato,

1994; Lantolf, 2006; Lantolf & Appel, 1994; Lantolf & Pavlenko, 1995; Lantolf & Thorne, 2006; Ricento, 1995; van Geert, 1994). Speech, speakers, and social relationships are inseparable (Norton, 1997). Activity theory emphasizes how individual learning is an emergent, holistic property of a dynamic system comprising many influences, both social, individual, and contextual (Lantolf & Appel, 1994). Action provides a context within which the individual and society, mental functioning and sociocultural context can be understood as interrelated moments (Wertsch, 1998; Wertsch, Del Rio, & Alvarez, 1995). Uttering invokes feedback that is socially provided (Tarone, 1997) and that recruits the learner's consciousness. Indeed consciousness itself is an emergent end product of socialization (Vygotsky, 1980; Wertsch, 1985). The associative network is culturally gated.

Keck, Iberri-Shea, Tracy, & Wa-Mbaleka (2006) synthesized the findings of the last 25 years of experimental studies investigating whether interaction facilitates the SLA of specific linguistic structures. Their meta-analysis showed that treatment groups involving negotiated interactions substantially outperformed control groups with large effect sizes in both grammar and lexis on both immediate and delayed posttests. Their analysis of the moderating variables additionally demonstrated that, as Loschky and Bley-Vroman (1993) initially proposed, communication tasks in which the target form was essential for effective completion yielded larger effects than tasks in which the target form was useful but not required. The first conclusion then is that successful usage of a construction that is essential for communication promotes acquisition; if that construction is initially unknown by the learner, interaction with a native speaker can help shape it, scaffolding its use and acquisition by allowing the learner to consciously notice and explore its form.

But there is more to their analysis. The comprehensible output hypothesis (Swain, 1985, 1993, 1995, 1998) proposed that in addition to comprehensible input, comprehensible output contributes towards L2 acquisition because learners make their output more comprehensible if obliged to do so by the demands of communication. Eight of the unique sample studies in the meta-analysis of Keck et al. involved pushed output, where participants were required to attempt production of target features, often because they played the role of information-holders in jigsaw, information-gap, or narrative tasks. On immediate posttests, the tasks involving pushed output produced larger effect sizes ($d = 1.05$) than those without ($d = 0.61$). Taking these findings together, this meta-analysis demonstrates the ways in which conscious learning, recruited in social negotiations that scaffold successful learner comprehension and, particularly, production, promotes the acquisition of targeted linguistic constructions.

Conclusions

I started with a Good Old-fashioned Psycholinguistic (GOP) analysis of language acquisition as the associative and cognitive processes of learning linguistic constructions as form-meaning pairings, and connectionist accounts of how linguistic generalizations emerge in associative networks from the patterns latent in a learner's usage history. But today's Psycholinguistics, let us call it a Modern Augmented Psycholinguistics (MAP), realizes that these associative networks are multiply embedded – they are embodied, attentionally- and socially- gated, conscious, dialogic, interactive, situated, and cultured. Language use, language learning, and conscious experience are all socially situated, negotiated, scaffolded, and guided. Language is constructed in social interaction.

It is difficult to analyze all of these components at once with the same rigor that is possible in a more focused attack, and hence they do not come to the fore in all computational and corpus linguistic psycholinguistic research. Yet they do feature. Krushke's (1992; , 1996; Kruschke & Johansen, 1999) computational models of associative learning include mechanisms of attention where each cue is gated by an attentional strength, total attention is limited in capacity, and the attention allocated to a cue affects both the associability of the cue and the influence of the cue on response generation. Thus, an exemplar unit does not record the raw stimulus, but the stimulus as perceived. Chen, Ballard and Aslin's (2005) connectionist model of word learning, already mentioned, has elements of joint attention guided by gaze-following. There is considerable work on the ways that the constructions used by one speaker affect the use and availability of the same constructions in their conversation partner by syntactic priming (Bock & Griffin, 2000; Boyland & Anderson, 1998; McDonough, 2006; McDonough & Mackey, in press), and much of Pickering's research (Branigan, Pickering, McLean, & Cleland, in press; Frisson, Rayner, & Pickering, 2005; Pickering, 2006; Pickering, Branigan, Cleland, & Stewart, 2000; Pickering & Garrod, 2006; Schoonbaert, Hartsuiker, & Pickering, 2007) concerning the 'dance of dialogue' is an explicit effort towards a new dialogic psycholinguistics.

The associative networks underpinning psycholinguistics are no more incommensurate with social action than are those underpinning human motor action and their integrated reflexes. As Sir Charles Sherrington, Nobel Laureate for his work on reciprocal innervation and inhibition in the neural networks of the spinal cord, put it: "If it is for mind that we are searching the brain, then we are supposing the brain to be much

more than a telephone-exchange. We are supposing it as a telephone-exchange along with the subscribers as well” (Sherrington, 1941).

A socioculturalist writing such a chapter would have started, I guess, with the necessity of interaction itself. Then, they too must surely have realized the insufficiencies of such beginnings. Socio-cultural processes, like associative and cognitive ones, are domain-general. They ignore the centrality of domain-specific problem spaces and causal frameworks. Without the details of psycholinguistic analysis, any understanding of language must be incomplete. A driving force of the Interaction Approach, as clearly exemplified in Gass (1997), is its dynamic integration of the social, psycholinguistic, and cognitive forces in SLA.

Domain-specific analyses are insufficient and ever will be. Language is a distributed emergent phenomenon. People and language create each other, grow from each other, and change and act under the influence of the other. Language and cognition are mutually inextricable; they determine each other. Language has come to represent the world as we know it; it is grounded in our perceptual experience. Language is used to organize, process, and convey information, from one person to another, from one embodied mind to another. Learning language involves determining structure from usage and this, like learning about all other aspects of the world, involves the full scope of cognition: the remembering of utterances and episodes, the categorization of experience, the determination of patterns among and between stimuli, the generalization of conceptual schema and prototypes from exemplars, and the use of cognitive models, metaphors, analogies, and images in thinking. Language is used to focus the listener’s attention to the world; it can foreground different elements in the theatre of consciousness to potentially

relate many different stories and perspectives about the same scene. What is attended is learned, and so attention controls the acquisition of language itself. The functions of language in discourse determine its usage and learning. Language use, language change, language acquisition, and language structure are similarly inseparable. There is nothing that so well characterizes human social action as language.

Cognition, consciousness, experience, embodiment, brain, self, and human interaction, society, culture, and history are all inextricably intertwined in rich, complex, and dynamic ways in language. We cannot understand language unless we have a good Interaction Approach. But not just Social Interaction. We require additional perspectives on dynamic interactions at all levels, perspectives provided by approaches such as Emergentism (Bybee, 2005; Bybee & Hopper, 2001; N. C. Ellis, 1998; N. C. Ellis & Larsen Freeman, 2006a, 2006b; Elman et al., 1996; MacWhinney, 1999), Chaos Complexity Theory (Holland, 1992, 1998; Larsen-Freeman, 1997; Larsen-Freeman & Cameron, In press), and Dynamic Systems Theory (de Bot, Lowie, & Verspoor, 2007; N. C. Ellis, 2007a, 2008a; Port & Van Gelder, 1995; Spivey, 2006; Thelen & Smith, 1994; van Geert, 1991).

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