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THE CRISIS OF TEXT
ISSUES IN THE CONSTITUTION OF AUTHORITY

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Talker-Listener Attunements to Speech Events

Carol A. Fowler* and Elena T. Levy**

We begin by focusing on animal-environment mutuality, a topic also addressed by Paul Wohlmut in his introduction. Human behavior generally is closely attuned to environmental constraints, but, of course it can exploit those constraints as well and even change some of them. Learning a skill (to adopt the example of the Introduction, learning highway driving) involves at once attuning to and exploiting environment and task constraints. What makes this mutual human-environment fit possible? We argue that, on the human side, fittedness to the environment is grounded in "perceptual realism." That is, we argue that natural selection has shaped perceptual systems to serve an essential function of acquainting perceiver/actors with their ecological niche. Thus, a "trajectory" of natural selection with regard to perceptual systems is toward reliable achievement of a relation of identity between components of the ecological niche and percepts of them, a relation that we call "parity."

Achievement of parity by perceivers depends both on properties of the environment and on properties of perceivers. In particular, in the environment, media, including light (for seeing), air (for hearing) and the perceiver's own body (for touch), are causally structured objects and events in the ecological niche. Further, it tends to be the case that different properties of the niche structure these media in ways distinctive to themselves. Therefore, structure in a medium can serve as information for its causal source in the environment. For their part, perceivers are sensitive to structure in informational media: their perceptual systems respond to it and use it to render knowledge of its source in the world.

The world does not give itself to passive perceivers. Perceivers have to obtain their knowledge by means of exploration. Indeed, many of their activities are exploratory ones in which the explorer attunes to properties of the explored event or object. These activities can be seen as evidence of one aim (or, again, in the highway metaphor, "trajectory") of perceivers' actions, namely to achieve perceptual parity.

We suggest next that perceptual realism makes communication possible, because communications are transmitted in part via perceptual systems. The necessity that, for the most part, perceiver/actors achieve parity in

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perception has shaped their perceptual systems in ways that make achievement of parity in communication a possibility as well. Here, parity is a relation of identity between the messages sent and received. For talkers and listeners, parity is possible because the fundamental primitives of spoken languages are articulatory. Accordingly, speaking involves activities of the vocal tract that are phonological components of the spoken message. Those activities causally structure the air in ways distinctive to themselves. Listeners' auditory systems respond to and use the structure to render knowledge of those components of the message. In the ideal, parity is achieved.

We and others find striking evidence for exploratory or attunement activities on the parts of participants in communicative exchanges that identify, as one of the trajectories of these exchanges, progress toward achievement of communicative parity. First, listeners' behaviors may serve a role analogous perhaps to one role of signposts along the highway. That is, they serve as guides, here to the speaker in the service of communicative efficacy. For example, facial or verbal signs of puzzlement will lead the talker to say more; signs of wandering attention may prompt termination of an utterance. Other nonlinguistic patterns of communicative behavior—for example variations in vocal intensity and in patterns of pausing during speech—show evidence of "accommodation," that is, of participants moving closer to each other on those dimensions in the course of an exchange and thereby getting on each other's wavelength as it were. Finally, we see patterns of elaborations and reductions of coding material at different levels and kinds of descriptions of a communicative exchange and even at different time scales. This includes, when information is new and unfamiliar to a listener, the speaker using more words to express an idea, using manual gestures to accompany the words, and providing more intelligible utterances of those words. Compatibly, as information becomes well-known to a listener in the course of an exchange, speakers use more opaque and less intelligible utterances and fewer gestural accompaniments. Thus, participants in communicative exchanges evidence dynamic attunement throughout the exchange, in the service, we believe, of efficient achievement of communicative parity.

Taking an aerial view of a highway reveals a "driving configuration." Stepping back from communicative exchanges to observe the longer time scale of language change also reveals a dynamic configuration, one that is very much like that observed in the shorter time frame and more local context of a single communicative exchange. When words are coined to describe something new, transparent names are often selected (e.g., "automobile," "videocassette recorder") with the consequence that something about the word's unfamiliar referent can be guessed from its name. However, when the items become well-known to members of a language community, opaque but more efficient names are used (in the examples, "car" and "VCR"). Similarly, but now in the articulatory,

rather than lexical, domain, words that are highly familiar to members of a language community (e.g., "particular") may be truncated (pronounced "pticular") whereas words that are unfamiliar ("particulate") are not. Accordingly, dynamic attunement occurs in the slower time scale of language change and in the larger community of language users as it does more transiently and locally in conversation, and we assume that, here too, it occurs in the service of efficient achievement of communicative parity.

We propose that, in communicative settings, talkers adjust the way that they speak to listeners in response to ongoing changes in the listener's presumed requirements to understand. We focus on two kinds of adjustment or attunement: Talkers produce more and less effortful articulations of words depending on whether the words convey, respectively, new or redundant information to listeners. In addition, in their use of referring expressions, talkers choose more and less transparent expressions, for example, noun phrases versus pronouns, to refer to individuals or things that are to a lesser and greater extent, respectively, presumed to be in the listener's attentional focus. Moreover, they are more likely to gesture manually when they produce transparent rather than opaque expressions. For their part, listeners attune to talkers as well. They express their attunement in part by imitative behaviors. We suggest that the function of these attunements of talkers to listeners and of listeners to talkers is to foster "parity" — that is, the receipt of a message by the listener that is, in fact, the message sent by the talker. Further, we propose that parity has its foundation in perceptual realism, and that attunement has its foundation in perceivers' explorations to achieve knowledge of their ecological niche.

Our focus is on the ways in which communicative behavior undergoes modulation in the context of ongoing discourse. Generally, we hope to show that there is a continual "attunement" of participants in communicative events to one another that is reflected at multiple linguistic levels and in nonlinguistic behavior that takes place as part of a speech event. By attunement, we mean activities on the part of talkers and other activities on the part of listeners that are intended to foster achievement of "parity."¹ Parity is an essential ideal of communicative systems that a message sent by a talker count as the same message for the listener. Fundamentally this means for spoken communications that, when a speaker talks, the listener must know that the sounds he or she is hearing counts as speech, not as noncommunicative mouth sounds. More than that it means that the listener must be able to recover an understanding from an utterance that, in the ideal, is the one intended by the speaker.

1. E.g., Liberman et al., 1989.

Although parity is an essential ideal of communicative systems, and attunement activities are special behaviors of talkers and listeners aimed at achieving parity, the foundations for parity and attunement can be seen elsewhere. Next we suggest that parity has its foundation in perceptual realism, and attunement has its foundation in exploratory activities of perceivers that are designed to achieve knowledge of the perceiver's ecological niche.

I. PERCEPTUAL REALISM

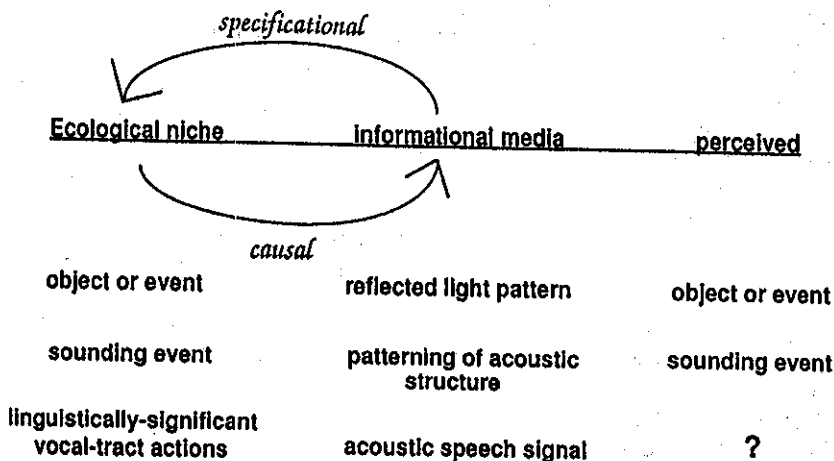


FIGURE 1.

Figure 1 may help to make these ideas clearer. The figure is meant to depict perception in its universal, public aspect.² Animals occupy "ecological niches" — that is, environments populated by objects, events and other animals relevant to the animal's existence.³ To survive, animals must come to know what populates their niche. Is a surface one on which the animal may locomote? Is an aperture one through which the animal may pass? Is a gap one across which the animal may step, or will an

2. In its public aspect, a theory of perception characterizes the environmental niche of a perceiver, the information about components of the niche that is available in informational media to which the perceiver's sense organs are sensitive (for example, reflected light for vision, acoustic signals for hearing, the surface of the animal's own body for touch). Research on public aspects of perceiving is designed to determine whether perceivers detect and use that information in perceptual guidance of action. In its private aspect, a theory of perception documents what happens in the nervous system of the perceiver as information detection by the perceptual systems and perceptual guidance of action are achieved.

3. Gibson, 1979.

attempt to do so cause the animal to plummet to certain injury or death? Is there another animal visible (or audible) in the vicinity of the perceiver? Is it predator, prey, or conspecific? Is it moving toward or away from the perceiver? Perceptual systems are the only means that perceivers have to acquire such information, and, accordingly, natural selection in evolution must have shaped perceptual systems to acquire it. The figure depicts how perceptual systems universally permit knowledge of an ecological niche to be acquired.

First consider visual perception. The objects and events that populate an ecological niche causally structure light. Fortunately, it tends to be the case that distinct properties of objects and events structure light in distinctive ways. Accordingly, there is not only a causal direction of effect (an arrow in the figure) from objects and events in the niche to structure in the light, there is also an informational or specificational "arrow" going the other way. That is, given a particular patterning over time of structure in the light, its causal source in the environment can be known. In a theory of perceptual realism,⁴ the evolved function of perceptual systems is to use such specificational arrows. It is, of course, structured light, not its causal source in an ecological niche that stimulates the visual system. Even so, however, the visual system renders perceptual knowledge of environmental objects and events, not of structured light. It does so by using the structure in light as information about that for which it is information — its causal source in the environment. In consequence, the visual system renders knowledge of environmental objects and events, and perceivers are realists.

As the figure suggests, perceptual realism implies that a kind of parity is achieved in perception. The environment of the perceiver is populated in some way, and the perceiver comes to know its population.⁵

The figure may suggest, mistakenly, that perceivers are passive knowers of the environment, but that is not the case. Rather, knowing the environment requires exploration, and the exploration required must be suited to the object of exploration. Large stationary objects can be explored by walking around them; small ones can be picked up by hand and examined; mobile objects may require yet other kinds of exploratory activities. We suggest that object-specific exploratory activities constitute a way in which perceivers attune themselves to their environment with an aim to know its components. An index of being attuned to properties of the niche is "resonance." For example, Shepard (1984) proposes that "as a result of biological evolution and individual learning [and we would add of moment-to-moment exploratory activities], the organism is, at any moment, tuned to resonate to the incoming patterns that correspond to the

4. Gibson, 1966, 1979.

5. This can be seen in Figure 1 by comparing the descriptors under the headings "ecological niche" and "perceived."

invariants that are significant to it." We will suggest shortly that perceptual resonance has visible and audible consequences in the behavior of listeners to speech.

Now consider auditory perception in the same way. Some kinds of events ("sounding events") in the environment causally structure the air.⁶ Happily, it tends to be the case that distinct sounding events tend to structure the air in distinctive ways.⁷ Consequently, there is both a causal relation between events and acoustic signals and a specificational relation connecting the signals back to the events. Accordingly, given a patterning over time in the air, properties of its causal source can be known. As for the visual system, the evolved function of the auditory system cannot be to render a percept of the structured air that stimulates the sense organ, here the ear. There is no survival advantage for a perceiver to know about structured air. There is, however, a survival advantage for the perceiver to know the cause of the structure. A small animal needs to know, for example, if there is, out of sight, a large animal moving stealthily in its direction. The claim of a theory of perceptual realism is that the auditory system evolved to use structure in the air over time as information for its causal source in an environment. Listeners, like visual observers, are realists; in the ideal, they achieve parity.

Now let us turn to speech perception and consider the implications of the fact that we use our auditory (and visual) systems to perceive speech. When speakers talk, they employ actions of the vocal tract having linguistic (most primitively, phonological) significance to convey their message. These actions causally structure the air.⁸ Generally, different linguistically significant actions of the vocal tract structure the air differently. Accordingly, in addition to the causal relation between vocal tract action and structure in air, there is an informational or specificational relation between air and action. We have claimed that the evolved function of perceptual systems is to foster perceptual realism by the systems' using information in the structured media to which sense organs are sensitive as information for their causes in the ecological niche. If that is accurate, then listeners to speech must use structure in the acoustic signal, not as something to be perceived in itself, but as a means of hearing the linguistically-significant vocal-tract gestures that caused the signal.

Further, perceptual realism in speech perception achieves "parity." If perception is successful, the listener recovers the phonological message sent by the speaker. Remarkably, from this perspective, parity is not a

6. See the middle panel of Figure 1.

7. For example, imagine two sounding events involving a drinking glass: filling the glass with water or dropping it and breaking it on a hard surface.

8. Some actions also causally structure light as when we close the lips to produce /b/, /p/, or /m/. Here, we focus on acoustic consequences of vocal tract gestures.

special feature of communication systems. Rather, it is grounded in perceivers' need to know their environments; it is grounded in perceptual realism.

The claim that listeners to speech hear the vocal tract actions of the talker (at the most primitive level of description of a speech event)⁹ is not popular in the field of speech perception.¹⁰ To buttress our claim and to lead into our discussion of listeners' attunements to talkers in speech events, we provide two pieces of evidence.

The strongest piece of evidence for perception of gestures is also the most complicated to characterize. It is that hearers attend to acoustic speech signals in a way that only makes sense if they are attempting to discover the vocal-tract gestures that caused them. Listeners' mode of attention is made clear by their perception of phonological properties of an utterance all of which have converging influences on such unitary dimensions of the acoustic signal as its fundamental frequency or duration.

The fundamental frequency of an utterance, physically, is the rate at which the vocal folds of the speaker's larynx open and close. It is approximately what we hear as a speaker's voice pitch. Thus, male adult speakers, on average, have lower fundamental frequencies than female adults, and male adult voices, in general, sound lower in pitch than female voices. However, the relation between fundamental frequency and perceived pitch is only approximate.

Speakers vary fundamental frequency to implement the intonation contour of an utterance — for example, to make a statement, to ask a question, or to issue a command: "You're going to the principal's office" versus "You're going to the principal's office?" versus "You're going to the principal's office!" However, other activities of the vocal tract may have consequences for fundamental frequency. For example, producing a "high" vowel, that is, a vowel in which the tongue moves toward a high position in the oral cavity, close to the palate, causes an increase in fundamental frequency on the vowel, possibly because the root of the tongue is attached to the larynx so that pulling the tongue up also pulls on the larynx and so on the vocal folds, causing them to open and close more rapidly. Producing an unvoiced consonant, one in which the vocal folds are held apart, causes an increase in fundamental frequency on a following vowel. Speech produced on an expiratory airflow is associated with a gradual downtrend ("declination") in fundamental frequency perhaps because the lungs are gradually deflating. Remarkably, listeners do not hear variation in fundamental frequency due to vowel height, to consonant

9. Our claim that listeners perceive linguistically-significant actions of the vocal tract is not a claim that such gestures are all that listeners perceive in speech events. Gestures are, in our view, the smallest perceivables of a speech message. Larger units, words, for example, may be perceived as well.

10. The alternative view is that listeners hear the acoustic speech signal, which acquires phonological significance by being assigned to a mental phonological category.

voicelessness, or to declination as variation in voice pitch. They "parse" fundamental frequency according to its various causes. They hear only the variation in fundamental frequency that the talker produced intentionally to generate the intonation contour as variation in voice pitch. A perturbation to the fundamental frequency contour due to vowel height or consonant voicelessness is heard, respectively, as vowel height and voicelessness in the consonant. Although no one yet has tested what declination is heard, as research has shown that it is not heard as part of the intonation contour.¹¹ Similar findings are obtained in investigations of listeners' perception of durational variation in speech.

This is one side of the speech-perceptual coin. Listeners parse unitary acoustic dimensions if distinct gestural causes have converging influences on them. The other side of the coin is that very different fragments of acoustic speech signals can sound the same if they are joint consequences of a common gesture. For example, 32 ms of silence inserted between an /s/ and the syllable /lit/ will lead listeners to hear the word "split," because the silence signals a closure of the vocal tract consistent with production of /p/.¹² However, much less silence (8 ms) that by itself is insufficient to signal /p/ between /s/ and /lit/, paired with appropriate spectral variation (labial "format transitions") before the /l/, will also be heard as the labial consonant /p/. Further the two renditions will be indistinguishable to listeners; both will sound like "split," and they will sound like identical "split"s. Remarkably, if one of the differences between the signals is removed — for example, if the labial format transitions before /l/ in the second described syllable is eliminated — so that now the two syllables differ in just one way rather than in two ways, the syllables are highly discriminable. One sounds like "split" and the other like "slit." In short, diverse acoustic fragments — here, a period of silence and format transitions — that out of context are highly discriminable, are indistinguishable just in case they both signal the same gesture of the vocal tract (lip closure for /p/ in the example).

The general point is that listeners parse acoustic speech signals into constellations of diverse acoustic fragments. Each constellation consists of the acoustic consequences of a distinct gestural cause. A tempting conclusion, certainly, is that listeners parse the signal as they do because they are perceiving gestures; they are perceptual realists. And they are achieving parity, at least at this most primitive level of description of a speech event.

A different finding that converges on the same conclusion may provide some insight into the kinds of attunement activities that we see listeners performing. In experimental psychology, two categories of reaction time

11. See Fowler, 1990 for a review of this literature.

12. Fitch et al., 1980.

paradigm are distinguished: simple and choice. An example of a simple reaction time task is one in which subjects sit with a forefinger on a response button, and they press the button as quickly as possible whenever a light flashes on the screen. An analogous choice reaction time task might have subjects with both forefingers on different response buttons; they press one button if a red light flashes and a different button if a blue light flashes. In general, response times in simple reaction time tasks can be as short as 150 ms on average, but choice reaction times tend to be considerably longer, say 250 to 300 ms on average. However, there is an exception to the latter generalization when the task involves speech. In a simple response time task involving speech, the subjects' task might be to say /ba/ whenever they hear a speaker say anything. In the corresponding choice response time task, when the speaker says /ba/, subjects respond /ba/ as quickly as possible; when the speaker says /ga/, subjects say /ga/; that is, they "shadow" the speaker. In this kind of task, choice response times can be as short, or nearly as short, as simple reaction times.¹³ Why does the speech task serve as a special case? It probably is not the "speech-iness" of the task that is important, but rather the fact that the task is to imitate. However, we will argue, this explanation only works if listeners to speech hear vocal-tract gestures.

Imagine first that listener-subjects do hear gestures. When they hear the talker say /ba/, they hear, for example, that the speaker closed his or her lips. The easiest response of all, requiring no arbitrary choice, is for the subjects to close their own lips — that is, to imitate. If, instead, listeners hear acoustic speech signals themselves, the reason for the super-fast response times is unknown. Having heard an acoustic signal, the listeners have to figure out what to do with their own vocal tracts to produce an acoustic signal that matches the one they heard, and that is a choice task, not a simple task.

The purpose of describing these last findings, however, is not just to defend the ideas that listeners to speech are perceptual realists and that realism fosters achievement of parity; it is also to lead to a discussion of listener attunements to talkers and of the form they take. Notice that our account of findings that subjects' responses in a choice response time task can be as short as simple reaction times implies that any imitative task — an accelerated version of the game Simon Says, for example — should also lead to super-fast response times. To our knowledge, this prediction is untested. However, if this generalization from the speech findings is accurate, it implies that imitation is very easy for people to do.

Further, there is evidence that observers of speech events are disposed to imitate. McHugo, Lanzetta, Sullivan, Masters and Englis (1985) recorded from the zygomaticus major muscle of the lips (active during

13. See, e.g., Porter et al., 1980a; Porter et al., 1980b.

smiling) and corrugator supercilii muscle of the forehead (active during frowning) of subjects viewing a videotape of then President Ronald Reagan giving a speech. Subjects were selected to have had either a positive or a negative prior attitude toward the President. Findings were that, regardless of prior attitude and especially with the sound track turned off, viewers' zygomaticus muscles were active when Reagan smiled, and their corrugator muscles were active when Reagan frowned. That is, viewers' expressed achievement of parity, in the form of a primitive kind of empathy, whether they were consciously sympathetic or hostile. Below we suggest that such imitative expressions of achieving parity constitute one reflection of listeners' attunement to talkers in communicative exchanges.

II. LISTENER-TALKER ATTUNEMENTS

A. *Attunement to Nonlinguistic Patterns of Vocal or Nonvocal Behavior*

A review of the literature by Cappella (1981) reveals some of the ways in which participants in a speech event may attune one to one another. Conversing individuals who differ initially in the typical durations of their pauses¹⁴ or in the latency with which they begin speaking after a turn change (after the previous speaker has ceased talking)¹⁵ may gradually converge on common durations of pauses and common latencies. Compatibly, they may approach one another in vocal intensity.¹⁶

They may adopt one another's speech rhythms as well. Spoken English is said to exhibit a particular kind of rhythm, called "stress timing," in which, to a first (and not very close) approximation, intervals between stressed syllables (e.g., the odd-numbered syllables in the first line of "Mary had a little lamb") are equal in duration. A recent study by Couper-Kuhlen (1993) suggests that turn-taking is often rhythmically cohesive. That is, at a turn transition, where one speaker finishes talking and another begins, a new speaker frequently begins "on the beat" of the speech rhythm established by the previous speaker. If Couper-Kuhlen's (1993) conclusions are correct, participants in a speech event may mutually establish and maintain a common speaking rhythm.

More weakly established is an idea that speakers and listeners may exhibit "interactional synchrony" — that is, both speakers and listeners may move parts of their body (not necessarily the same parts) synchro-

14. Jaffe et al., 1970.

15. E.g., Matarazzo et al., 1967.

16. Natale, 1975.

nously,¹⁷ and these movements may themselves be synchronized to the talker's speech rhythms. Alternatively, talkers and listeners may jointly establish a rhythmical organization the beats of which are stressed syllables in their speech or movements of the body.¹⁸ These activities of listeners suggest an attempt by them to get on the talker's "wavelength" — that is to achieve resonance.

Earlier we suggested that attunement in communicative events may have its foundations in exploratory activities of perceivers striving to come to know the properties of their ecological niche. Imitative behavior may not look very much like exploratory activities, but we think that it is in an important respect. Listeners strive to determine the message sent by the talker, and verification that they are succeeding is resonance as described earlier. That is, imitative behavior indexes the listener being on the talker's "wavelength." Anecdotal evidence of listeners who finish talkers' sentences for them may constitute extreme cases of such behavioral manifestations of listeners' achieving parity.

III. ATTUNEMENT OF TALKERS TO THE CHANGING KNOWLEDGE STATE OF THE LISTENER

Together¹⁹ and separately,²⁰ we have been focusing our recent research on a different, quite remarkable kind of attunement, now of talkers to the communicative requirements of listeners. As a consequence of the information that talkers provide in what they say and do during a communicative exchange, listeners' knowledge states change, and talkers appear to take that change into account as they choose how to express themselves. We review our own findings and related findings of other investigators next.

A. Articulatory Attunement

Bolinger (1963, 1981) proposed that talkers lengthen words durationally that are unexpected in their contexts. A reason for the lengthening might be to enhance the intelligibility of words that the listener is not expecting to hear. A complementary finding would be a shortening or other kind of reduction of words when they are overdetermined by their context. One research finding suggests that that may occur as well.²¹ Lieberman (1963) measured the relative intelligibility of redundant and nonredundant

17. E.g., Condon, 1976.

18. Erickson et al., 1982.

19. Fowler et al., 1991.

20. Fowler, 1988; Fowler et al., 1987; Levy, 1984; Levy et al., 1992; McNeill et al., 1993.

21. Lieberman, 1963; cf. Hunnicutt, 1985.

words (for example, utterances of "nine" originally produced either in the sentence "A stitch in time saves nine" or in "The next word you will hear is nine"). Extracted from the contexts that made them either redundant or nonredundant, the words differed significantly in intelligibility such that redundant words were less accurately identified by listeners than were nonredundant ones. By implication, talkers produced reduced (less effortful), and therefore, less intelligible versions of words when they knew that listeners could identify the words from their contexts and so did not need as careful an articulation of the word as when the context supplied no information about the identity of the word being spoken.

In ongoing communicative exchanges, the redundancy of words can change. Words used to introduce a new topic may be unexpected by the listeners, but the same words used later as the topic continues to be discussed are likely to be more predictable. Still later, as conversational partners go on to different topics, the words may once again become unexpected. We may ask, then, whether talkers modulate the way that they articulate words in response to these transient variations in predictability. Evidence suggests that they do. A first finding is that talkers reduce words durationally (because they reduce them articulatorily) that they are producing for the second time in a discourse as compared to words they are producing for the first time.²² Further, the shortening is enough to affect the intelligibility of the words. When Fowler and Housum (1987) extracted spoken words from a monologue and presented them in isolation for identification, listeners made more errors to words that, in the monologue, were second occurrences of words than to words that were first occurrences.

One possible interpretation of the finding is that talkers produce an articulatorily less effortful version of a word when they gauge that they can get away with it, and they can get away with it if the listener already has an idea of what will be said.²³ Presumably, this is the reason why words in Lieberman's (1963) clichés were relatively unintelligible. Other interpretations are possible, however. Reductions can be supposed to be unrelated to the talker's assessment of the listener's requirements to hear more or less careful speech. For example, articulation of a word may "prime" the articulatory routine that talkers use to say the word, and that priming may increase the rate at which the routine plays out the next time it is used to produce the word. If so, then the shortening is an unintended consequence of word repetition, not an attunement of speaking to the listener's requirements to achieve parity.

Several findings suggest that the first interpretation of the shortening effects is more viable than interpretations such as the second that do not

22. Fowler et al., 1987; Fowler, 1988.

23. As above, a complementary way to think about it is to say that talkers produce a more effortful, hence more intelligible, version of a word when they must.

implicate the listener. First, words repeated in a list are not reduced²⁴ as they should be if reductions reflect priming of articulatory routines. Second, nouns repeated in discourse are only shortened if they have the same referent on both occasions.²⁵ That finding is expected if the talker shortens only when s/he assumes that the listener has the referent in mind (and that a listener will have a referent in mind if it has recently been mentioned). It is unexpected if shortening reflects articulatory priming. Third, there is weak evidence for shortening of words preceded by synonyms rather than by themselves²⁶; accordingly, articulatory repetition is not required for shortening. Fourth is a recent finding that some narrators lengthen their productions of redundant words if they have introduced a scene or episode shift between earlier and later productions of the word.²⁷ There is no reason relating to articulatory priming why this should occur. However it is consistent with an interpretation that shortenings are made with the listener in mind. This is so because scene shifts in a story may make antecedents from a previous scene less accessible to readers of a story (and presumably also to listeners to a story) than referents renamed within a scene.²⁸

If we accept that the shortenings do have something to do with the fact that repeated references are occurring in a communicative setting, a next question to ask is whether, when shortening does occur, there are indications that the talker can "get away with" the reduction because the listener already has information that the word may occur. Fowler and Housum (1987) found two indications that the repeated words they examined had extra-acoustic sources of boosts in identifiability. They used a cloze procedure in which readers attempted to fill in missing words from a transcript of a monologue and found that second occurring words were significantly more predictable from their contexts — necessarily later into the monologue — than were first occurring words. Accordingly, the findings are similar to those of Lieberman (1963); words were reduced articulatorily (and were less intelligible heard out of their context) if they were redundant. A second finding derived from the experiment on the intelligibility of first and second occurring words was already described. As described, words that had occurred first in the monologue were more intelligible, presented in isolation, than were second occurrences. However, another finding in that experiment was that, regardless of whether a word had occurred first or second in the monologue, it was identified more accurately by listeners if it came after a prior occurrence of the same word in the identification test. That is, listeners benefitted

24. Fowler, 1988.

25. Bard et al., 1991.

26. Fowler, 1988.

27. Fowler et al., 1994.

28. Anderson et al., 1983.

from having already heard (a different token of) a word before in the text.²⁹ In short, it appears that talkers can get away with a less effortful production of a word when the word is predictable from its context and when they have already said the word recently in the listener's hearing. Under those conditions, listeners can successfully identify reduced versions of words that they might misidentify in less predictable contexts.

We take the systematic articulatory reductions of repeated words in redundant contexts as evidence that talkers are inclined to speak as effortlessly as they can without sacrificing communication. Therefore, they continually gauge the knowledge state of the listener — a state they may gauge in part from visible and audible evidence of the listener's attunement to them. When they estimate that the listener has a pretty good idea what they will say, they speak less intelligibly than when they estimate that the listener is in the dark.

A question that we have not successfully answered is whether the talker's behavior is not only tolerable for the listener, but, in addition, might even be useful to him or her. We know that listeners can identify repeated, reduced words in their proper contexts. Is it possible that, more than this, the reductions supply useful information? Fowler and Housum (1987) attempted to address the question in two ways. First they asked whether listeners could tell, from a word presented in isolation, whether it was the first occurrence of a word by the speaker or a second occurrence. In fact, listeners were able to do this task with better-than-chance accuracy when they were told that repeated words were reduced. This finding led to the hypothesis that listeners might profit from knowing in discourse that a word had been reduced, because the reduction signifies redundancy, and the redundancy implies that the word or its referent had been mentioned before. Because listeners and readers are known to integrate information about repeated referents as part of the process of comprehending discourse,³⁰ the hypothesis was that reduced versions of words would trigger efforts to retrieve earlier relevant information and hence would promote comprehension-enhancing information integration. Although Fowler and Housum (1987) obtained a little favorable evidence, it was weak and was not replicated by other investigators.³¹ Accordingly, the question remains unanswered.

We do know that talkers attune themselves to the listener's varying communicative requirements for intelligibility. We do not yet know whether listeners attune themselves to the information available in the occurrences of reductions.

29. For a similar finding on words presented in noise, see Goldinger, 1992.

30. E.g., G. Dell et al., 1983.

31. Bard et al., 1991.

B. Gestural Attunement

Another kind of articulatory reduction may be observed in the manual gesturing of speakers. Gestures, like articulatory lengthenings, are more likely to occur when the references they accompany are unexpected in their contexts of occurrence. In an analysis of a spontaneous conversation, Levy and McNeill (1992) found that pointing gestures tended to occur when a topic was being established and rarely occurred after that. There is also evidence that gestures occur more often with full noun phrases, such as proper names and definite descriptions, than with attenuated forms such as pronouns and zero anaphors. In one analysis of a narration, Marslen-Wilson, Levy and Tyler (1982) found that, of thirty-one references made with full noun phrases to the two main characters in a story, fourteen were accompanied by gestures. In contrast, none of the fifty references made with pronouns or zero anaphors were accompanied by gestures.³² (As McNeill (1992) points out, however, a zero anaphor can be accompanied by a gesture if a processing pause occurs at that point.) Related findings are described by McNeill (1992), who found that, in one narration, gestures occurred fifteen times with noun phrases, verb phrases and clauses, yet they never accompanied unstressed pronouns. Interestingly, McNeill (1992) noted that, on three occasions in which gestures did accompany utterances that contained unstressed pronouns, in each case the gesture did not overlap temporally with the articulation of the pronoun.

It appears that gestures may be used to signal to listeners that the references they accompany will be of some importance in the discourse that follows. In analyses of four speakers' narrations of a film, Levy (1984) ranked the characters referred to in order of their overall frequency of mention in each narration. Of those characters ranked one and two, five of the eight introductory references were accompanied by gestures; of the remaining characters, most references (twenty-four of the twenty-six) lacked accompanying gestures.

Related to this, analyses of the internal structure of narratives indicate that talkers tend to use gestures to accompany references that follow the use of explicit structural markers, such as scene shifting devices. In such cases, references that occurred earlier in the discourse are treated as if they are new information, or unexpected in their contexts of occurrence. In the study of Marslen-Wilson, Levy and Tyler (1982) cited above, of twenty-five references to characters made with proper names, eighty-six percent

32. Full noun phrases, in contrast to less explicit forms such as pronouns, tend to occur in unexpected discourse contexts. See "Lexical Attunement" below. Zero anaphors occur, for example, as the subject of the second verb in "Charles got up and left the room."

of those that occurred initially after explicit scene markers were accompanied by gestures, whereas gestures accompanied twenty-two percent of those that occurred subsequently in scenes. In a parallel analysis of a narration, Levy (1984) found that of ninety-nine references to characters made with full noun phrases, sixty-three percent of those in episode-initial position were made with gestures, whereas only twenty-seven percent of those in subsequent positions were made with gestures. There is a suggestion in the literature that this finding may be cross-cultural.³³

C. Lexical Attunement

There is an analogue of the articulatory reductions just described that occurs at a different level of description of a talker's speech that Levy (1984) and Levy and McNeill (1992) found when they examined the distribution of referring expressions in a set of narrations. The narrations were of a film (an episode of a television miniseries) that the narrator, but not the listener, had recently seen, and the referring expressions were references to main characters in the film.

Expressions referring to a character can vary in lexical length. That is, they can be noun phrases, including syntactic phrases ("Charles Ryder, one of the main characters in the film") and names ("Charles Ryder" or "Charles"), for example. Or, they can be the much shorter and less transparent pronouns (e.g., "he") or even zero anaphors. Levy (1984) and Levy and McNeill (1992) found that narrators' choices of length of referring expressions were associated statistically with two measures of linguistic context, one local and one global, that were related to the redundancy of the referent with respect to its mention earlier in the episode.

The local measure, coreferentiality, was used to code references as relatively redundant or nonredundant with respect to a single clause in the text that immediately preceded the target reference.³⁴ Statistical analysis showed that pronouns and zero anaphors were more likely to be used in coreferential than in noncoreferential contexts, and longer referring expressions tended to be used in coreferential contexts.

The global measure of redundancy, called "density" by the investigators, reflected whether the character referred to by an expression under examination was or was not the most frequently mentioned character in an approximately paragraph-sized segment of the narration just before the present mention of the character. "Dense" characters were statistically associated with short referring expressions (pronouns or zero anaphors),

33. See Levy et al., 1992.

34. A reference was considered to occur in a "coreferential" context if it referred to the same character as the last male reference to occur in a parallel syntactic position in its clause.

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and "sparse" characters with longer, noun phrase expressions. Interestingly, this pattern held even when both local and global measures of redundancy were included in the same analysis. That is, shorter referring expressions occurred at times in dense contexts even though the referent's local context predicted that a longer expression would occur.

Both of these findings appear analogous to those by Fowler and Housum (1987) in showing that lexically as well as durationally shorter, less transparent, forms are used when the speaker can assume that the referent of the form is well-known to the listener and is in the listener's attentional focus. Apparently, talkers choose short forms in redundant contexts and can shorten in either or both of two ways; they can reduce a given word articulatorily and/or they can choose a short lexical form.

The narrations examined by Levy (1984) and by Levy and McNeill (1992) showed a third kind of patterning in the narrators' use of longer and shorter referring expressions. Levy (1984) partitioned each narration into episode units, using expressions such as "Now the next scene that you see" as episode delimiters. Three of the four narrators showed a statistically significant tendency to use long referring expressions for the first mention of a character in an episode even if the character was "dense" and "coreferential." That is, they used a form that was more explicit or transparent than the listener required to identify the character. The fourth narrator showed a marginal tendency in the same direction. This may indicate that narrators use lengths of referring expressions to provide information, redundant with scene delimiters, that the scene has shifted. It is analogous with the somewhat less consistent findings by Fowler and Levy (1994) described earlier, that some narrators lengthen words durationally after a scene shift.

As we have attempted to do for patterns of articulatory reduction, we can ask whether the talker's lexical attunements to the knowledge state of the listener, in fact, benefit the listener in any way. Does talkers' use of a pronoun reflect a wholly "selfish" strategy of using a short form when they can get away with it without sacrificing the listener's achievement of parity? Or, does the pronoun actually communicate better to the listener than more transparent referring expressions would do in certain contexts?

As research by Levy and McNeill (1992) has shown, pronouns tend to occur when their referents have been mentioned with higher frequency recently, than have other referents in a narration. Other research³⁵ has shown that readers (and, so presumably also listeners) integrate different pieces of information provided about a referent even when the different pieces of information occur several sentences apart in a story. Use of a pronoun, rather than a full noun phrase, provides evidence that a listener or reader might use to cue them that there is information about the same

35. E.g., Dell et al., 1983.

referent already stored by the listener that, for best comprehension of the story, should be retrieved and integrated with the new information.

There is some evidence that pronouns do serve such a cuing role. Cloitre and Bever (1988) presented sentence pairs to listeners (and, in another condition, to readers; results were similar across conditions, and, here we focus on listeners). In the following example from their experiment, listeners heard sentence 1 and one of sentences 2a-c:

1. The gangly busboy spilled soup on the famous actress.

2a. A waiter ran to help the busboy.

2b. A waiter ran to help him.

2c. A waiter smothered a giggle.

Following the sentence pair, listeners heard a "probe word" ("gangly" in the example above), and they pressed one response button as quickly as possible to signal that the probe word had appeared in the previous sentence pair, or, in cases in which the probe word had not appeared in the sentence pair, listeners pressed a second response button. Response time was the dependent measure.

Notice that, in sentences 2a and 2b, the busboy is mentioned overtly either by use of the noun phrase "the busboy" or by use of the pronoun "him." The busboy is not mentioned in 2c. Earlier research³⁶ had shown that a second mention of the argument of a proposition (here, a character in the story) led subjects to retrieve information associated with its earlier mention from a previous sentence in which the character was mentioned. In their research, reference to a character, such as the busboy in sentence 2a above, led subjects to retrieve information associated with the mention of the same character in sentence 1. Therefore, probe words such as "gangly" in our example were associated with faster responses after sentences such as 2a, in which reference to the busboy occurred, than after sentences such as 2c, in which a second reference to the busboy did not occur. Notice that "gangly" occurs in sentence 1, but not in sentences 2a-c. However, "gangly" is a descriptor applied to the busboy, who is mentioned in sentence 1 and again in sentence 2a. That response times to probe words such as "gangly" were faster following sentences such as 2a than following sentences such as 2c suggests that a second reference to the busboy in 2a prompted retrieval of information about the same character from sentence 1, including, therefore, the information that the busboy was gangly. The novel finding by Cloitre and Bever (1988) was that the fastest response times of all to probe words such as "gangly" occurred after sentences such as 2b in which reference was made using a pronoun. The pronoun served as a better prompt for "gangly" than did "the busboy" in sentence 2a perhaps because use of a pronominal form signals that the

36. G. Dell et al., 1983.

referent of the pronoun has been mentioned before and thereby fosters retrieval and integration.

Even though a pronoun is a more opaque referring expression than a noun phrase, in settings in which speakers tend to use pronouns, listeners can benefit from their use. We think that they benefit because the talker's use of a pronoun signals them that the reference is to a someone or thing that has been recently mentioned. For best understanding of a story, information about a referent needs to be integrated across mentions, and the pronoun signals that retrieval of earlier information and its integration with the new information is required.

Complementarily, there are locations in a narration in which Levy and McNeill's (1992) research suggested that use of pronouns is not favored. Here we focus on locations in which an episode shift intervenes between mentions of a character in a narration. Even when measures of redundancy indicate that use of pronoun would be unambiguous across an episode shift, narrators use noun phrases predominantly. This may be consistent with evidence of Anderson, Garrod and Sanford (1983) that antecedents of pronouns are not as rapidly accessed across an episode shift as within an episode, at least for antecedents presumed unlikely to be present following the shift (for example, diners in a restaurant if five hours have elapsed since their arrival at the restaurant). Talkers may use noun phrases after a scene shift to protect listeners against this loss of accessibility of a pronoun's antecedent.³⁷

IV. ATTUNEMENT AT SLOWER TIME SCALES

The patternings of articulatory elaborations and reductions and of lexically longer and shorter referring expressions that we have described occur in communicative exchanges between or among a small number of people, and they are transient. That is, they occur as referents which transiently become less and more well-known to conversational partners.

In larger groups, and at slower time scales, we can see analogous elaborations and reductions that occur when a referent is initially unfamiliar to a language community but later becomes familiar to most members. First, regarding articulatory reduction, Mowrey and Pagliuca (1987) suggest that words tend to wear down with use. Their example is the word pair "particular" and "particulate." For most speakers of English, the first word is very familiar, whereas the second is not. Mowrey and Pagliuca (1987) suggest that, although the two words begin with the same sequence of phonemes, /partlkyul/, and have the same stress pattern, their first syllables tend to be pronounced differently. Whereas "particular"

37. However, we must consider this interpretation tentative, because Anderson, Garrod and Sanford (1983) did not test whether the antecedents of noun phrases suffered a similar loss of accessibility.

may be pronounced "p'ticular," for most speakers "particulate" must remain "particulate." Compatibly, the first author, a native of Rhode Island, pronounces one of the state's cities (Pawtucket), "P'tucket," but she hears it pronounced "PAWtucket" by out-of-state sportscasters referring to the minor league baseball team, the Pawtucket Red Sox; the second author, a native of New York City, refers to "M'nhattan," whereas the first author pronounces the first syllable's "a." In short, it appears that, when words become chronically well-known to a large group of speakers, the words may undergo chronic articulatory reduction.

With regard to lexical length of words, shortening may also occur. When words are coined, for example, to name something new, the names are often composed of morphemes that suggest the nature of the named object. Hence, for example, "automobile" is a vehicle that moves on its own. A more recent example is "videocassette recorder" — a device that records films on a cassette. The reason for coined words' transparency may well have more to do with the kinds of names that are easy to think of than with any effort on the part of namers to provide an informative name. However, a consequence is that a listener, never having heard the word "automobile" before, for example, can learn a little about what the referent of the name might be from the name. It is interesting, therefore, that names often get shorter when their referents become well-known to members of a language community. Zipf ([1935] 1965) suggested that words shorten in two ways. "Moving picture" shortened by means of truncation to "movie," and "automobile" shortened by substitution to "car." The shortening of "videocassette recorder" to "VCR" may be a third kind of shortening, or, possibly, it counts as a substitution.

Just as "he" is a less transparent referring expression than is "Charles Ryder," so the words "movie," "car," and "VCR" are less transparent than the originally coined names. Moreover, just as the transient lexical shortening of "Charles Ryder" to "he" occurs in contexts in which the listener expects "Charles" to be mentioned, the shortening at the longer time scale occurs when members of a language community know well what the named object is and do not require a transparent name to help them understand its nature.

V. SUMMARY AND CONCLUSION

We have described some ways in which the literature suggests that listeners attune to talkers in the course of a communicative event, and we have summarized our research and that of others showing that talkers attune to the changing knowledge state of listeners as a communicative event proceeds. Attunement takes place, we believe, in the service of the achievement of parity — an essential ideal of communicative exchanges such that the message that the talker intends to send is the same as the

message received by the listener. The listener's efforts to discover what talkers are attempting to communicate manifest themselves as imitative or entrainment (or resonance) behaviors. Attunement of talkers to listeners is, perhaps, more interesting. Talkers behave, at more than one level of description of a speech event, and in their nonverbal as well as verbal behaviors, as if they are obeying Grice's (1975) maxim of quantity: they provide as much information as, but no more information than is required for the listener's understanding. Because information being conveyed undergoes continuous modulation in respect to the extent to which it is both well-known to the listener and at the forefront of the listener's attention, talkers exhibit modulations in their provision to listeners of elaborated, transparent lexical and articulatory forms or else more opaque and articulatorily reduced forms. Compatibly, communicative conditions that lead to production of transparent lexical forms and, we predict, articulatorily unreduced forms, also foster use of manual gestures, which may provide further elaborative information to the listener. Gestures are less likely to occur in association with opaque referring expressions, and, we predict, articulatorily reduced forms. Presumably monitoring listeners' attunement behaviors helps guide talkers' modulations of information provision.

We suggest that parity and attunement have their foundations in evolutionarily older, more basic, and more general requirements and activities of perceivers/actors. Parity may constitute an example of the more basic requirement for survival that we called "perceptual realism" — the requirement that perceivers come to know the components of their ecological niche. Given a property of the niche such as a surface that affords locomotion or food that can be eaten, animals must come to know that property to survive. Attunement activities of listeners may have their foundation in the exploratory activities in which perceivers/actors engage in an effort to discover the properties of their environment. Imitative behavior that manifests the listener's effort to discover the talker's message may reflect the "resonance" property of perception.

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