The Role of Feedback in Language Processing

A defended thesis

about human parsing

Teresa Pelka, M.A.

2026
WITH A GLOSS

Copyright

ISBN 9781500957094

Format and language of the original:

A4, American English.

Font face: Noto Light.

Content

Preface

Tests by Peter Ladefoged proved speech and language dependence on intrinsic feedback without exception. Human DNA requires cellular feedback for active protein, that is, everyday living. In tests on volunteers, human endurance under insufficiency of intrinsic feedback has been evidenced lower than for thirst or hunger.

When I was writing the thesis, the Hodgkin-Huxley hypothesis as a mathematical model was already not prominent in neurophysiological study, yet the theory that cell membranes have ion channels remains affirmed by Erwin Neher, Bert Sakmann, and Roderick MacKinnon. Cellular and systemic feedback is a biological fact. The thesis defends its importance as approximate to a drive, the relevant instinct being that for individual self-preservation.

The work considers feedback as a biological phenomenon at the cellular level, examines its effects within the human nervous system, and analyzes the role in language.

Feedback performance does not refer to evaluative behaviors that everyday language may connote. The notion of a drive does not indicate any gender-oriented function. The work regards human nerve, muscle, and cognitive structures in contexts linguistic as they by standard can be.

Philology has not been much of association with language neural detail. The progress that literary and poetic pursuits have made into language psychology has yet encouraged reasonable inclusion, freedom from prejudice or bias to be an asset.

The tutor, professor Stanisław Puppel of Adam Mickiewicz University, offered the topic of feedback in class. I wrote my thesis in English, defended on September 28, 2000, at the very same university in Poznan, Poland. The thesis language of original is American English; I offer my translation to Polish as well. The work entire is based on legal publications. It never required, and does not solicit experiments. Reasoning was my ambition.

Teresa Pelka, M.A.

Introduction

Language is a prerequisite for human reasoning abilities, and neural processing has been evidenced in natural language learning as well as use. Human parsing for language can be regarded as human processing of information, where terms as *a system, program, and option,* though correlative with computer science, are not to imply close a correspondence, since natural language may remain unmatched by artificial intelligence. Human neurophysiology opens the following discourse on the role of feedback in human language command.

Living organisms use DNA-encoded information, for growth and sustention. These genetic codes have been compared to programs (Young, 1984), where a *program* may be understood as *a system plan for a routine solution of a problem* (after the Webster's Unabridged Dictionary, 1989). Biological life depends on structure regeneration (Young, 1984). Homeostasis, in requiring inner biochemical selection and exchange of no direct conscious adjustment, may exemplify a biological task.

In biology, systemic selection and exchange may involve a single cell and structures as complex as the human being. Whereas DNA patterns for active protein have been acknowledged as biological programs, not only basic sequences of cellular activity have been found to rely on feedback for enactment (Vander et al., 1985), feedback in information processes to have been defined as *returning of part of the system output to be reintroduced as input* (Webster's Unabridged Dictionary, 1989).

Positive and negative types of feedback have been recognized, where the former is also known as regenerative feedback and aids the input, whereas the latter opposes it, hence the alternate term, "inverse feedback". Cellular outputs accrue into schemata that allow learned behaviors. Integrated neural patterns can be thus posited to rely on feedback for formation, effectuation, and permanence.

Regarding control in routine operations, Norbert Wiener insisted that feedback belonged with neuroscience as well. In neurophysiology and psychology, feedback productiveness can be understood as a closed-loop capability over open-loop sequences (Puppel, 1988, 1996). No less than a requirement by the nervous system, intrinsic feedback must be of effect in the neural reality for natural speech and language. The system is studied with focus to feedback phenomena in the cellular, intercellular, and interschematic dimensions, toward speech and language generally.

For a competent insight into natural language, the inquiry refers to human communication as well. Psycholinguistics to be the framework of the intended pursuit, feedback phenomena are studied in language learning and use, the discourse further to reason on repair or compensation, within the posited language faculty of man. Natural and principled occurrence having become affirmed in human neural and psychological function, feedback reliance can be argued to approximate a drive, the relevant instinct being that for individual self-preservation. In the view to human information processing, feedback would be an initiating, mediating, and modeling factor.

Chapter 1. Neurophysiology of feedback

Discourse on information processes requires terms as a *system*, *program*, *option*, *signal*, and *feedback*. Human logical skill does not work in denial of the nervous system. Beginning with the single cell and concluding with the inherent coordination by the brain, the system can be discussed as an information processing and managing structure. Congruity with terms of information having been attained, feedback systemic occurrence may become appraised for a natural principle.

1.1. Feedback in the single neuron

Positive and negative feedback types have been evidenced in human nervous systems already at the level of individual cells, during change of bioelectric potential. Positive as within the ionic hypothesis by Alan Lloyd Hodgkin and Andrew Fielding Huxley, feedback works in action potential depolarizing phase. To promote intracellular stability, cellular active transport involves negative feedback (Vander et al., 1985).

Action potentials are brief, all-or-none reversals in neuron polarity (ibidem), and thus natural language can be stated to use processing of options. Singular neural impulses are yet more than likely to fall within systemic allowance for error, saltatory propagation to depend on combined synaptic consequence. The basic level of nervous system structuring, individual cells can be of result in higher variables only as part in networked capabilities, neural networks to build on cell particular locales.

1.2. Intercellular time and space

Individual neurons may communicate with thousands of synapses. Signals are initiated mostly by joined synaptic activity and launched in series. Integral with neural diversity and specialization, spatial arrangement of synapses or cell receptors is vital, neurons locally to develop varied thresholds. Second messenger extra-synaptic interaction may decide neural conveyance, in areas of high-density non-myelinated brain tissue. By and large, these are local outcomes to resolve on action or graded potentials of autonomic structures (Vander et al., 1985).

Neural communication time span yet cannot be disregarded, inhibitory and excitatory values to summate in real time. It is in all neural consequence that feedback depends on time extent for effect. Outcomes of neural correlativity would derive from biological functioning to degrees greater than allowed within theories of extrinsic timing (in: Puppel, 1988).

The theories approve of the temporal aspect as extrinsic to the speech plan, the time span to be set on phonetic segments in the speech act implementation phase. A major argument to the contrary may come with the property by human nervous systems constantly to show part preparatory actuation, diagnostic techniques as PET or MRI to focus on the degree of cellular engagement rather than its presence alone. Biological performance pertains with any living cell.

Nonoperational in a process, neurons are not inactive, and cell resting state is interior dynamic balance with exterior.

Intrinsic in timing, neuron homeostatic stochastics may result in action potentials. Excitation as in an isolated cell is predictable only in terms of statistical approximation, whereas systemically the resting state is reference in polarity change (Vander et al, 1985).

Principles of biological activity have been premised to correspond at lower and higher levels of systemic structuring (Coles and Duncan-Jones in: Ciarkowska, 1993). Feedback reliance might thus be a natural phenomenon in the single neuron, as well as language-capable networks in the brain.

1.3. Human systemic dynamics

Neural bonding for speech and language gives shape to schemata and networks, where no singular corpus of tissue can be posited for the master control center over the brain entire. Human schemata may embody speech sound or letter shape representations, likely of a multiple exponence that enables of the networked contingency in planning for spoken or written discourse (Puppel, 1992).

The natural affinity between neural actuation and motor behavior has been difficult to detect or measure (Vander et al., 1985). Speech and language yet observably do employ feedback inner dynamics rather than strictly a hierarchy.

Brain neocortex is the tissue of the highest intricacy; brainstem reticulate structures are yet vital in mediating neural conveyance for the systemic long distance. Reticular projections help guide multisynaptic pathways and communicate nervous system autonomic, central, and peripheral specializations. The brainstem has been indicated for neural information processing by ten cranial nerves, of the twelve. It helps harmonize eye movement, cardiovascular and respiratory performance, neural patterns for sleep, as well as routines for wakefulness and focused behavior, inclusive of learning and language (ibidem).

A subcortical body, the brainstem assists phonation and language visual processing, whereas cortical activity may influence breathing, the very reticular form to convey the cortical signal. Central and autonomic coordination is direct, in the pupillary and other smooth muscle rapport for speech, reading, or writing.

In experiments on environment stereotyped intake or rejection (in: Ciarkowska, 1993), John Lacey described a cerebral influence over cardiac outcomes that held likewise, for people evaluating their concurrent contexts, and those expected to predict experiment developments. The researcher reported a parametric pattern wider than direct response and pointed to afferent feedback, for the impression by intellective faculties over autonomic lifework.

Engel, Malmo, and Shagass (ibidem) proceeded further with psychosomatic variance, to posit person-specific patterns in neurophysiological function. The researchers reported autonomic parameters that corresponded with psychological tasks, thus evidencing a learned factor in biological bodily routines. The lifework is experienced as naturally reflex and outside aware control; individuate negotiation would solicit systemic feedback.

1.4. A human reflex arc

In definition, reflexes are automatic and indeliberate. Arc typical constituents are the receptor, afferent pathway, integrating center, efferent pathway, and the effector. Research in human neurophysiology has yet declared that “most reflexes, no matter how basic they may appear to be, are subject to alteration by learning; that is, there is often no clear distinction between a basic reflex and one with a learned component” (Vander et al., 1985).

A reflex arc may consist of a stimulus to nerve A, looped via the brain with nerve B. The nerve may synapse on endocrine gland B1, and hormonally communicate with gland C, which may in turn actuate a muscle through another messenger, neurochemical C1. It is yet often difficult distinctively to name arc components. Neurochemicals of immediate effectiveness as well, do have potential for multiple accomplishment (ibidem).

Neural messengers are able to act as neurotransmitters at neuron terminals; via the bloodstream, as hormones or neurohormones, and locally as paracrines or autocrines. A vasoconstrictor in homeostatic controls, vasopressin may be released upon change in peripheral blood vessel resistance. Connoted with response to stress, it has been found of significance to learning and memory in contexts that did not require exertion (ibidem).

1.5. Human reflex and voluntary behavior

Voluntariness has been disputed, with reference to the neural reality of living structures as inclusive of man. Without impediment, and with regard for skill and knowledge, majority of human behavior would belong somewhere in a continuum between the voluntary and the involuntary, rather than within strictly defined boundaries for deliberately actualized intention (Vander et al., 1985).

Walking, though conscious and volitional by standard, employs co-exercise of muscle structures that base on networks of interneurons to engage information pools by spinal local levels. Interneurons can work as “signal changers" between afferent and efferent terminals. The same cells may take intrinsic descending command, and receive from local patterns. Upon local feedback, motor pattern change is to a good degree reflex (ibidem).

Corticospinal and brainstem paths are mostly outside interoception. The former are prominent in supplying the hands; the latter are essential in positioning and movement of the head (ibidem). Not only writing, the fine motor behavior of speech as well, would exercise a substantial amount of established patterns, where the person does not need to pay close attention to the particular. Locally, these are neural elementary sets to manage antagonistic muscle routine inhibition. At the level of language segments, production and perception do not require much focus to the fine motor detail, unless a disturbance occurs (Puppel, 1988).

Muscles cannot work without relevant and active neural paths, hence a phrase as *relevant neuromotor patterns* has become of use (Vander et al., 1985). Favorable reference may advocate the *neuro-motor-articulatory* *mastery* (in: Puppel, 1992). An outline on relevant pattern building may help understand the role of feedback in human language behavior.

1.6. Relevant neuromotor patterning

Volitional practice is not opposed to, or independent of reflex activity, at neuromotor pattern formative stages already. Universal parameters are unlikely to become agreed, for the multineuronal loops that mediate thought and behavior, or the network hidden layers that are part in neural schemata shaping and use. Some hypotheses on neuro-motor pattern establishment yet have been developed (Vander et al., 1985).

Behavior voluntary repetition can alter the number or effectiveness of synapses between relevant neurons. Early stages of pattern forming would depend on intrinsic feedback heavily. Repetition to have encouraged new synaptic accord, the initially extensive reliance on feedback would gradually diminish, to promote behavior economy and ease (ibidem). For speech and language, skill observably affords no effort, with the minutiae of articulatory or graphemic finesse.

To cluster or syllable extents, established patterns for speech and language can compare with programs, in their work as open-loop sequences. Evidenced for natural language segments as "slips of tongue" (Puppel, 1992), spoonerisms are the widest in extent, in brain open-loop processing for language.

The intrinsic monitoring of spoken or written ability never yet does desist completely. Neocortical feedback is able to initiate, end, as well as in real time instruct established neuromotor sequences, also for language generative and new activity. The primary roles of sustained feedback are error-correction and feedforward, the anticipatory cortical command for neuro-motor planning. The CNS neural grasp integrates all sensory modalities.

1.7. Human pooling of sensory information

Language acquisition or initial stages of learning may favor conscious and selective focus to auditory and tongue muscle tactile data, vital in shaping speech sounds. Cortical monitoring for established language skills yet also would use pools of sensory information that enable feedback on paralleled inputs, though by standard difficulty or disadvantage is mostly moderated within the central sensory scope known as intra-modal adjustability (Vander et al., 1985).

Proprioception and kinesthesia are part the information for the central monitoring of speaking or writing; difficulty promotes visual data (Puppel, 1992). Visual distortions impel increased attention to hearing and touch. Auricular obstruction directs focus to tactile and visual data (Vander et al., 1985).

Intra-modal adjustability may show in a person raising his or her voice to speak, also if wearing headphones on purpose. Since own speech patterns belong with validated neural linkage, elevated auditory feedback would be in real time to verify the spoken performance. Alternately, the objective may be attained with extended reliance on tongue muscle tactile variables.

1.8. The pool model for human homeostasis

Homeostasis requires of bodily biothermal gain and loss to balance in exchange with the environment for intra-systemic inputs. In humans the homeostatic “operating point” is a spectrum of variables that contribute to a standard threshold. Another name for the spectrum is that of the homeostatic pool (Vander et al., 1985).

Human homeostasis works essentially on negative feedback. In thermoregulation, increase as well as decrease would induce actuation that counters change. Body temperature is anticipated in feedforward, whereas skin receptors remain at a discrepancy with internal thermosensitive sites. Homeostatic operative values never do balance error signals entirely; the difference helps sustain the bioregulatory activity. Biothermal feedforward is in part learned, and people are capable of moderate climatic adaptation (ibidem).

The biochemical equilibrium is of relevance to cognitive faculties directly, as indicated in distortions compelled by illness or another extrinsic factor. Experiments with sensory privation (Lindsay and Norman, 1991) had healthy and otherwise not deficient volunteers exhibit perceptual defects, and low-level unvaried stimuli proved even more “hallucinogenic” than limitation on peripheral inputs alone. Tolerance time span for feedback insufficiency was shorter than for fasting, and financial offers did not motivate continued endurance. In regeneration of inner balance, threshold maintained reference must have required systemic feedback and signal specificity.

1.9. Signal specificity and the human brain

Human brains form neural networks that connect the volition-oriented cerebrum and brain autonomic locales. The networks are capable of labile activity, and failure by a labile component may bring a spectrum in response. Brain matter has a cumulative compensatory potential. In standard circumstances, the organ may replace or even void a defective variable (Styczek, 1983).

Brain coherence becomes possible with neural fibers and tracts. Three types of linkage are named most often, for brain integrated performance: associative connections join regions within the same hemisphere; projection paths communicate the cortex with the brainstem, basal ganglia, cerebellum, and the spinal cord; transverse tracts convey between the hemispheres, the corpus callosum making the most acknowledged connection (Akmajian et al., 1984).

Though they do not have sensory cytostructuring, brain frontal areas enhance neural discernment in linkage with parietal, temporal, occipital, and limbic tissues. Frontal feedback may change the limbic emotional component, whereas limbic inputs have been given much credit for personal awareness of the self (Vander et al., 1985).

Of areas widely connoted with speech and language, motor sequencing is assisted by frontal lobe Broca, adjacent on Brodmann motor extents. Broca feeds back with temporal lobe Wernicke for the underlying spoken or written shape. Brain occipital areas support the visual data for memory of language written forms, and those of the dominant temple distribute for speech acoustic parameter, while brain parietal matter harmonizes sensory and cognitive variables. Speech potentially does afford language trace visual representations, and written text may invoke trace auditory features of no acoustic content.

Brain primary receptive areas neighbor on structures considered secondary or *gnostic* (Styczek 1983). This is most probably the dominant gnostic or secondary auditory area to connect with the neural array capable of language forms that Wernicke may reconstrue (ibidem). The short-term capacity for signal reprocessing would be the "phonetic buffer" in Puppel (1998), or the "echo box" in Lindsay and Norman (1991).

Neocortical specificity for speech and language is emboldened by cranial nerves. The vagus, facial, abducens, glossopharyngeal, trigeminal, and trochlear pairs consist of both motor and sensory fibers, thus qualifying for feedback connectivity thoroughly (Vander et al., 1985).

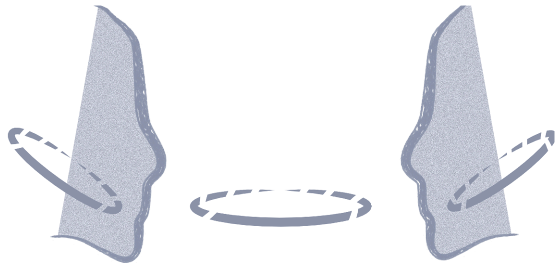
The cerebellum feeds back with the neocortex and brainstem nuclei, integrating vestibular information from the ears, eyes, muscles, and skin. Cerebellar memory is part the feedforward in movement planning. Timing signals for the cortex and spinal generator arrays, cerebellar inputs are highly specific (ibidem).

Closed-loop capability is part in any spoken or written act. Interoceptive feedback would use proprioception and kinesthesia, bringing cognitive mapping value as well. Exteroceptive feedback would use tactile, auditory and visual inputs.

Interoceptive or exteroceptive are yet only classes in which to note rather than delimit on the senses. In a speech act, tongue tactile variables are interoceptive, whereas palpation as of written realizations would be exteroceptive, the sensory modality being that of touch.

In conversations or written verbal exchanges, two classes of feedback might be advisable for purposes of clarity as well, egocentric feedback to embrace interoception and exteroception in each involved person, environmental feedback to emerge with linguistic interaction.

Figure 1. Feedback dual model for conversational exchange.



The egocentric or self-oriented feedback would hold for the articulators or the written capability in the hand, the speech sound or written medium, the ears and eyes, and brain primary auditory or visual matter. Standard physical parameters would apply in these extents, whereas human gnostic areas already might bring much individual specificity, before thought might gain response from the mind.

1.10. Conclusions

The human nervous system does meet the requirements for human processing and management of information. The neural structure does form a system and use all-or-none options, where open-loop sequencing would depend on feedback and signal specificity in real time.

Dependence on feedback has been found of direct relevance to life processes throughout the human internal hierarchy, beginning with the single cell and ending with the human brain. The requirement is biological and regular, and thus occurrence of intrinsic feedback does qualify for a natural principle.

Distortion to feedback capabilities may render the human nervous system nonoperational at all its levels. Reference to the self-preservation instinct as premised in the thesis introduction is validated in human neurophysiology.

No alphanumeric or binary codes are posited for human inner information, as humans by standard do have language, which is not an alphanumeric or binary code. Human systemic information would be more of an operative indication (after Webster's Unabridged Dictionary, 1989), be it for molecule or impulse quantity, positioning, or interval.

A monosynaptic reflex might be stated to operate on a single datum of biological information. Human systems yet observably favor polysynaptic and pooled processing. Evolved for higher systemic functions (Vander et al., 1985), human sensory pools can work with evolutionally the highest, neocortex ideational linkage for language and thought.

The operative indication would be present in a biological program as well as in the accompanying pool of feedback. The information cannot be always uniform, and thus the basic notion of feedback as a closed-loop capability is validated.

An intrinsic and natural principle in living biological structuring, feedback occurrence might induce orientation to it. Whereas the dispute on nature versus nurture may never become resolved, forced or scheduled incidence would deny the natural principle, and thus it could only meet select qualities of artificial parsing.

Artificial intelligence may differ from human information for indefinite future, as non-representative of living human tissue. Information technologies having been originated by man, their purpose is to use data presets for tasking. The manner has never been expressive of human inner reality.

In the egocentric scope, human systemic information would gain or affirm on the status of internal values. Among people, information would be attained through communication, research, or instruction (the Webster's Dictionary, 1989), and feedback would use standard parameters for speech or writing.

Language study shows the human internal reality would not result from strictly evolution of biological programs. Reasoning on the role of feedback in language learning may help consider intrinsic feedback for evolutionary and thus speciate contexts.