Gestures and Growth Points in Language Disorders[1]

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Introduction

Gestures shed light on thinking-for-(and while)-speaking. They do this because they are components of speaking, not accompaniments but actually integral parts of it. Much evidence supports this idea, but its full implications have not always been recognized. For comparison, cf. modular-style modeling in de Ruiter (2000) and Kita & Özyürek (2005), based on the theory of speech production in Levelt (1989). Modular theory and its spin-offs are incompatible, we have argued, with the integration of gesture into speaking (McNeill, 2000; McNeill & Duncan, 2000). They require a fundamental separation of speech and gesture; the 'modules' exchange signals but cannot combine into a unit. The growth point (GP) hypothesis, which we describe here, is designed in contrast to explicate this integral linkage. In a GP, speaking and gesture are never separated, and do not occupy different brain processes that must in turn then be linked (cf. the brain model section, below). A key insight is that speech on the one hand and gesture (or, more broadly speaking, global-imagistic thinking), on the other, when combined into a GP, bring together semiotically opposite modes of cognition at the same moment. This opposition, and the processes that speakers undergo to resolve it, propels thought and speech forward; semiotic contrasts are a key component on a dynamic dimension of language. It is in this mechanism that we seek insights into language disorders. We explore four situations—disfluent (agrammatic) aphasia, Down's syndrome, Williams syndrome, and autism. Each can be seen to stem from a breakdown, interruption or inaccessibility of a different part of the GP, and from a disturbance of the dynamic dimension in general. Considered together, they manifest—by interruption—aspects of the processes of thinking-for/while-speaking itself. We have not attempted to review gesture study, the growth point, the psycholinguistics of speech production, or language disorders, but do spell out some implications of a new paradigm in which language and cognition are embodied (cf., Johnson, 1987) and dynamic, and show how a theory within this paradigm, the growth point, leads to new insights into four language disorders.

The growth point

The GP is so named because it is a distillation of a growth process—an ontogenetic-like process but vastly sped up and made functional in online thinking-for-speaking. While we are not addressing language acquisition as such we regard it as a general model of cognitive change valid across many time scales. According to this framework, the GP is the initial unit of thinking-for/while-speaking (from Slobin, 1987, elaborated to include thinking online, during speech) out of which a dynamic process of utterance-level and

discourse-level organization emerges. Imagery and spoken form are mutually influencing. It is not that imagery is the input to spoken form or spoken form is the input to imagery. The GP is fundamentally both. The following exposition of the GP covers essential points for the purpose of elucidating language abnormalities but it is necessarily brief; more thorough presentations are in McNeill & Duncan (2000), McNeill (2005), McNeill (2007) and, with a language origins slant, in McNeill et al. (2008).

A 'minimal unit' of imagery-language dialectic

The GP is an irreducible, 'minimal unit'[2] of imagery-language code combination. It is the smallest packet of an idea unit encompassing the unlike semiotic modes of imagery and linguistic encoding. A GP is empirically recoverable, inferred from speech-gesture synchrony and co-expressiveness.[3] Even when the information (the 'semantic content') in speech and gesture is similar, it is formed according to contrasting semiotic modes. Simultaneous unlike modes create instability. Instability fuels thinking-for-speaking as it seeks resolution (McNeill & Duncan, 2000).[4] The result is an idea unit in which holistic imagery and discrete code are combined, and this drives thinking-for/while-speaking.

Example

The temporal and semantic synchronies represented in Fig. 1 imply a GP built on the idea of rising interiority. We infer the simultaneous presence of the idea of ascent inside the pipe in two unlike semiotic modes.[5] The speaker was describing a cartoon episode in which one character (a cat named Sylvester) tries to reach another character (a bird named Tweety) by climbing up inside a drainpipe. The speaker is saying, "and he tries going **up thróugh** it this time", with the gesture occurring during the boldfaced portion (the illustration captures the moment when the speaker says the vowel of "thróugh"). Co-expressively with "up" her hand rose upward and co-expressively with "thróugh" her fingers spread outward to create an interior space. These took place together, and were synchronized with the entirety of "up thróugh", the linguistic package that carries the same meanings.

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[2] The concept of a 'minimal unit' with the property of being a whole is from Vygotsky (1987: 4-5), concisely stated in this passage: "By a unit we mean a product of analysis which, in distinction from elements, possesses all the basic properties of a whole. Further, these properties must be a living portion of the unified whole which cannot be broken down further..." (Vygotsky, *Thinking and Speech* [Russian 1934], p. 9, quoted in Zinchenko, 1985: 97).

[3] A growth point is inferred (not 'operationally defined') from a) gesture form, b) coincident linguistic segment(s), c) co-expression of the same idea unit, and d) what Vygotsky (1987: 243) termed a 'psychological predicate' in the immediate context of speaking.

[4] The reasons why semiotic opposition creates instability and initiates change include:
  a) *conflict* (between semiotic modes: analog imagery/analytic categorical), and
  b) *resolution* (through change: fueling thinking-for-speaking, seeking stability).
Simultaneous semiotic modes comprise an inherently dynamic psycholinguistic model.

[5] Computer art from video by Fey Parrill, now at the Department of Cognitive science, Case-Western University. All figures, except Fig. 4, are from McNeill (2005). Used with permission.

Fig. 1. Gesture embodying 'rising hollowness' synchronized with "up thróugh".

The GP pairs linguistic segments with a uniquely gestural way of packaging meaning – something like 'rising hollowness', which does not exist as a semantic package of English at all. Speech and gesture, at the moment of their synchronization, were co-expressive, yet embodied this shred idea in contrasting semiotic modes. The very fact there is shared reference to the character's climbing up inside the pipe makes clear that it is being represented by the speaker simultaneously in two ways—analytic/combinatoric in speech and global/synthetic in gesture.

And context

An important point is that we can fully understand what motivates any gesture-speech combination only with reference to how a GP relates to its context of occurrence. The GP-to-context relationship is mutually constitutive. The GP is a point of differentiation from the context, what Vygotsky termed a 'psychological predicate'. The speaker shapes her representation of the context, or 'field of oppositions,' to make this differentiation possible. A robust phenomenon is that the gesture form and its timing with speech embody just those features that differentiate the psychological predicate in a context that is at least partly the speaker's own creation. In the "up through" example, interiority is newsworthy in a field of oppositions concerning Ways of Getting at Tweety By Climbing Up A Pipe; a previous description had been that it was on the outside, now it is on the inside (see McNeill, 2005, pp. 108-112).

The catchment

The effective contextual background can often be discovered by finding the catchment(s) of which a target gesture is a part. Catchments are when space, trajectory, hand shapes, etc. recur in two or more (not necessarily consecutive) gestures. The recurring imagery embodies the discourse theme (the metaphor comes from the land area—'the theme'—that drains—'the significant oppositions'—into a body of water—'the GP'). For both climbing up the outside and climbing up the inside of the pipe the same space and trajectory occurred (iconically depicting Sylvester's entrance at the bottom of the pipe)—verbally, too, the full expression, "he goes up thróugh it this time," indexes the catchment theme in that the inside ascent was a recurrent attempt. Newsworthy content appears as a modification of the catchment, relating itself to the theme while also adding new contrast. For the inside ascent the speaker's hand rose at the lower periphery, as before, but now also created the open space seen in Fig. 1—not only a shape change but also, to the up-the-pipe theme, adding the newsworthy content that it was on the inside this time. Jointly with co-expressive "thróugh," prosodic emphasis also highlighting interiority, the gesture was part of a fresh psychological predicate in this context.

Catchments, if they are present or absent and if present how they are formed, and what restrictions if any they impose on potential discourse themes (cf. Furuyama, et al., 2008), are important variables we can conceptualize systematically by applying the GP theory to the three language disorders. We are unaware of other approaches that frame these questions.

Unpacking the GP

Unpacking is to create the structures with which to stabilize the combintion of unlike cognitive modes in the GP. It is 'unpacking' the growth point into a grammatical construction (or viable approximations thereto) that preserves the core significance of the GP while cradling it in a stable grammatical format. Achieving this often takes additional meaning formulation. The process is regulated by the speaker's linguistic intuitions—called 'intuitions-1' (a sense of well-formedness and contextual appropriateness of the linked semantic frame).[6] The construction also supplies a 'stop-order' for the impulse to change initiated by the imagery-linguistic code instability. In Fig. 1, "up thróugh" is analytic: up-ness and interiority are separated and combined grammatically. The linguistic encoding has meaning because it combines meaningful parts. The synchronous gestural image embodies similar information without combining separately meaningful parts —'Sylvester as rising hollowness'; the gestures parts are meaningful only because of the gesture as a whole. Unpacking resolves the tension of the semiotic modes. The full construction, "(he) goes up thróugh it this time", its co-expressive elements exactly synchronizing with the gesture stroke, preserves the GP, does not dim the highlighted interiority, and adds indexing of the catchment value—that it was a second ascent—which was also in the gesture.[7]

At times, of course, unpacking fails. A construction may not be found; or one is found but its semantic pattern conflicts with the GP on some dimension; or the conflict is with the field of oppositions, the context of the GP. It is important to keep these possibilities in mind, for they appear in different language disorders. To illustrate one case, not a chronic disorder but a momentary interruption of normally fluent speech, we offer an example from a paper with Nancy Dray (Dray & McNeill, 1990)—the 'nurturing' example: a speaker (having a conversation with a friend) was attempting to convey a delicately nuanced idea, that a third person she was describing was given to performing nurturing acts, but these good deeds were also intrusive, cloying, and unwelcome. Initial false starts were based on the use of "nurture" as a transitive verb (she would "nurture" someone) and were repeatedly rejected as inappropriate. Ultimately the right construction was found. The field of oppositions was initially something like, Things This Woman Would Do, and "nurture" was an appropriate significant opposition. The direct object construction the speaker first attempted ("she's. . . she's nu- uh") means, roughly, that the woman described has a direct transformative impact via nurturing on the recipient of her

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[6] To be distinguished from 'intuitions-2' with which a linguist tests possible analyses, often evoked with purpose-constructed forms designed to violate some rule under test.
[7] When gesture and speech synchronize, the two modes are in direct contact. If there is less than perfect synchrony, the GP can still urge unpacking. The ultimate criterion is whether an idea is embodied in two forms (with or without different aspects of the idea) and this creates instability. However, incomplete synchrony can also open the process to error, as we see next.

action. However, this meaning distorted the idea the speaker intended to convey—an oblique reference that separated effect from act. A slight updating of the field of oppositions to something like *Otiose* Things This Woman Would Do yielded the final construction, which could differentiate it appropriately with a meaning of doing something without implying transformative efficacy ("she's done this nurturing thing"). This example illustrates a subtle but far from uncommon occurrence of GP differentiation, context shaping, and unpacking going awry.

Further comments

Some additional comments to fill out the GP picture:

 • First, the following question may come to mind: If gesture is 'part of language,' how could it and language be 'semiotically unalike'? We admit a certain polysemy in the word 'language'. When we say gesture is part of language, we mean language in the sense of Saussure's *langage*. When we say that gesture contrasts to language we mean it in the sense of *langue*. We are analyzing *parole*/speaking but we believe in a way broader than this concept in Saussure (although Saussure himself, in his recently discovered notes, seems to have had the aim of combining *parole* and *langue*— here we rely on Roy Harris's, 2003, interpretation).

 • By 'gesture' most centrally we mean a kind of semiosis that is both 'global' and 'synthetic'.[8] By 'global' we mean that the significance of the gesture's parts (= the hands/fingers/trajectory/space/orientation/movement details of it) is dependent upon the meaning of the gesture as a whole. The parts do not have their own separate meanings, and the meaning of the whole is not composed out of the parts; rather, meaning moves downward, whole to parts. This is the reverse of the linguistic semiotic mode, where the meaning of the whole is composed out the parts, which for this to work must have their own separate meanings. By 'synthetic' we mean that the gesture has a meaning as a whole that may be analytically separated into different linguistic segments in the speech counterpart.

 • Another contrast is that gestures (and imagery more broadly) lack so-called 'duality of patterning'. The form of the gesture-signifier is a non-arbitrary product of the signified content (including, via metaphor, abstract 'non-imagistic' meanings), so its form doesn't need or get its own level of structure (= 'patterning' in the Hockett, 1960, phraseology). Speech again contrasts: it has this duality of patterning—meaning and sound are each structured by schemes at their own levels, and are paired arbitrarily.

 • This has to do with the role of convention and where it intrudes. There are conventions of good-form for speech, but none for gesture (apart from the well-known emblem vocabularies in every culture; also general kinesic conventions for how much space you can use, whether you can enter the space of an interlocutor with a gesture, and the many kinds of metaphor that constrain forms in their gesture versions. These however are not specific gesture conventions in parallel with the sound-system conventions of speech).

 • Even constructions, like "up through it," while they are macro-units, don't negate the possibility of decomposing them into separately meaningful subunits (up, through, it).

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[8] 'Gesture' in this sense is realized in the manual, bodily, and vocal (prosody) modalities.

Also, the meaning of "up through it", as a construction, is still something traceable to lexical atoms. The gesture on the other hand does not admit any decomposition, since there are no subunits with independent meanings, no repeatable significances to the outspread fingers, upward palm and motion upward (arguably, there is upward motion and it independently means upward, but there are exceptions to this seeming transparency as well, gestures where up-down signifies the vertical dimension as a whole, and up actually means down in some cases). Significance exists only in the whole gesture. Also, we think the gesture is more a unified whole than just the combination of up and through; we have tried to convey the unification with the expression 'rising hollowness' but whatever the phrase, the gesture has interiority, entity, and upward motion in one undecomposable symbolic form.

- In a growth point, then, two semiotic modes, contrasting in the ways listed above, combine to embody the same underlying idea. The instability of having one idea in two 'unlike' modes fuels thought and is the dynamic dimension of language viewed psycholinguistically.

- In the verbal modality, as in the manual modality, the meaning of the first part ("up" or the spread fingers) remains, as Liesbet Quaeghebeur (pers. comm.) wrote, 'alive', 'present', or 'active' while the second part is being produced ("thróugh" or the upward movement). There is this kind of continuation in both cases, but the explanation differs—a construction in the verbal case; a global image in the gesture case. The continuities differ as well—sequential in the linguistic form, simultaneous in the gesture. Between the two means of attaining continuation the difference comes down to whether symbolic actions are organized by syntactic patterns or by imagery.

Four language disorders

We now make use of the GP hypothesis to elucidate aspects of three forms of language disorder. The four are disfluent (agrammatic) aphasia, Down's syndrome, Williams syndrome, and autism. To develop our analyses, we begin by proposing the necessary aspects of a brain model.

A brain model

Based on what we currently understand of gesture-speech semiosis a neurogesture system (see McNeill 2005 for supporting references) involves both the right and left sides of the brain in a choreographed operation with the following parts: The left posterior temporal speech region of Wernicke's area supplies categorial content, not only for comprehension but for the creative production of verbal thought; this content becomes available to the right hemisphere, which seems particularly adept at creating imagery and to capture discourse content. The right hemisphere could also play a role in the creation of GPs. This is plausible since GPs depend on the differentiation of newsworthy content from context and require the simultaneous presence of linguistic categorial content and imagery, both of which seem to be activated in the right hemisphere. The frontal cortex may also play a role in constructing fields of oppositions and psychological predicates, and supply these contrasts to the right hemisphere, there to be embodied in GPs. Underlying the rhythmicity of speech 'pulses' (cf. Duncan, 2006) and interactional entrainment (cf. Gill, 2007) we assume a continuous circulation of cerebellum inputs or

feedback. Finally, the right hemisphere and the prefrontal cortex are almost certainly involved in metaphor. The results of processing (right hemisphere, left posterior hemisphere, frontal cortex, cerebellum) converge on the left anterior hemisphere, specifically Broca's area, and the circuits specialized there for action orchestration (cf. McNeill et al, 2008, for a brain mechanism, 'Mead's Loop', to account for how GP units of speaking and gesture can be formed). Broca's area may also be the location of two other aspects of the imagery-language dialectic—the generation of further meanings in constructions and their semantic frames, and intuitions of formal completeness to provide 'stop orders' to this dialectic. All of these—left, right, frontal—can be called 'language areas' of the brain.

The language centers of the brain have classically been regarded as just two, Wernicke's and Broca's areas, but if we are on the right track in our sketch of a brain model, contextual background information must be present to activate the broader spectrum of brain regions that the model describes. Typical item-recognition and production tests would not tap these other brain regions but discourse, conversation, play, work, and the exigencies of language in daily life would.

Disfluent (agrammatic) aphasia

The 'verb problem' in Broca's aphasia is the tendency to omit or nominalize verbs in utterances (Miceli, et al., 1984; Zingeser & Berndt, 1990). On the assumption that verbs are the core syntactic constituents of utterances, this symptom has been studied and interpreted by some as evidence in support of a neurologically-grounded grammar 'module'. However, depending upon discourse context, verb salience varies within-language and across languages, depending on facts about verb behavior in each language. Conceptualized in the GP framework, Broca's aphasia arises from a more or less severe disruption of the unpacking cycle, but the GP itself (formed, we hypothesize, by the uninjured right hemisphere with inputs from the prefrontal cortex and the posterior left hemisphere language area) is unimpaired. A Broca's aphasic speaker differentiates psychological predicates in reasonably constituted fields of oppositions, but is unable to unpack the GP. The following excerpt (Duncan & Pedelty, 2007: 271) is a Broca's aphasic's description of Sylvester trying to reach Tweety by climbing the drainpipe (apparently on the inside). There are only two identifiable verbs, "is" and "shows". In contrast, six noun tokens were uttered generally clearly and forcefully (Table 1).

Table 1. Agrammatic Aphasic's Description of a Cartoon Event

(1) the (pause) vlk- (pause) uh (breath) bird? (pause) and c- (breath) cat
(2) (pause) and uh (breath) ss- uh (pause) she ss- (breath) (pause) apartment
(3) and uh- (pause) the (pause) uh (pause) old (pause) my (breath) ss- uh (pause) woman (pause)
(4) and uh (pause0 she ss- (pause) like (pause) uh ae- f- f-fas-t (breath)
(5) cat (pause) and uh (pause) bird is-ss-ss (pause) (breath)
(6) I uh (pause)
(7) (breath) sh-sho- shows t- (pause)
(8) a- an' down (pause) t- d- down (breath)

Transcription from Duncan & Pedelty (2007: 271)

The speaker performed two well-synchronized, co-expressive gestures. With speech they constituted a likely (repeated) psychological predicate:

[a- and **down**] [(pause) **t- d- down** (breath)]

(Boldface font indicates a gesture "stroke". This is the meaningful phase of a gesture. Brackets indicate the larger gesture phrase. This is the period including preparation before and retraction after the stroke). The strokes in this instance were downward thrusts of the right hand synchronized closely with the two occurrences of the co-expressive path particle, "down", the second stammered. Fig. 2 illustrates these downward strokes.

Fig. 2.1-2.3 Gesture by a disfluent (agrammatic) speaker timed with "an' down" (2.1- 2.2) and "t- d- down" (2.3). Cf. Table 1.

In the context of the cartoon story that we, as observers, independently recognize, plus her own fragments of speech in advance of the two instantiations of the gesture, we can identify the gesture plus the synchronous particle, "down," as the single piece of newsworthy information in the excerpt. The speech-gesture pairings thus suggest an

intact GP (repeated). Equally important, no verbs occur at all as the linguistic components of the GPs and the verbs that did occur were utterly non-newsworthy; one a copula coupling nothing, the other "shows" showing nothing.

This lack of participation by verbs may be no accident. Duncan & Pedelty propose that in English and some other languages (they refer to Chinese as well), "…sentential main verbs are often not the information-loaded, discourse-focal utterance constituents that our usual ways of thinking about them would suggest." (Duncan & Pedelty, 2007: 280). The omission or nominalization of verbs in Broca's aphasic speech, whatever the role of their internal semantic complexity in causing an absence from picture-naming and other non-discourse tasks, is also a predictable result of how GPs embody newsworthy content in the context of speaking. Verb absence would accordingly be, at best, ambiguous evidence for in support of modular brain models of language.

Verb absence in Broca's discourse (as opposed to naming) can be explained by a lack of ready access to constructions. In normal speech, non-information-laden verbs enter utterances riding on these kinds of structures. Nonetheless, agrammatic speakers can formulate and differentiate contexts to obtain GPs. Thus our first illustration of language abnormality demonstrates a separation of GP formation and unpacking, normally two seamlessly fused (while analytically distinct) steps of utterance formation.

The lack of construction-access in Broca's aphasia, nonetheless, is far from absolute. With time and catchment support constructions can be accessed by even highly agrammatic aphasic speakers. A case described in McNeill (2005: 217) demonstrates the phenomenon: a patient began his description with single nouns but after more than two minutes of gradual expansion, accompanied by appropriate spatial gesture mappings, came out eventually with a two-clause, embedded sentence including appropriate verbs—slow speech indeed but far from 'agrammatic'. Fig. 3 depicts the stages in this gradual unpacking.
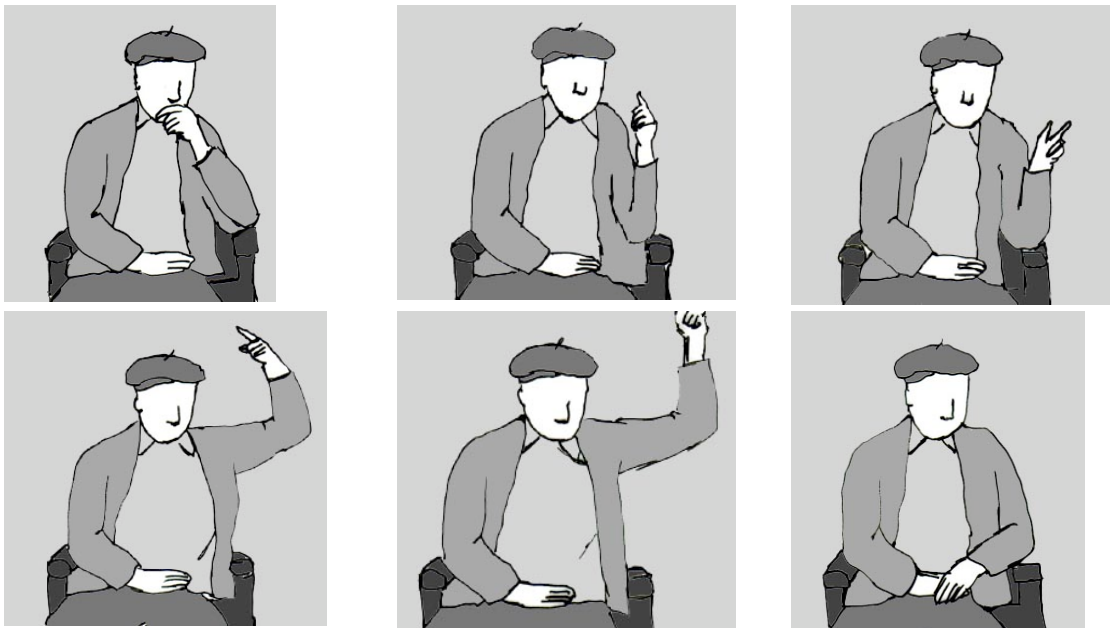

Fig. 3.1-3.6. Catchment from a disfluent (agrammatic) speaker made of repeated gestures in upper space.

The speaker begins by referring to a trolley as the 'el,' which is the local way of referring to Chicago's elevated train system. The important feature of the example is his repeated indicating of the upper gesture space—first raising his left arm at the elbow, then lifting his arm overhead. This recurrent indexing is a source of gestural cohesion. Verbally, speech was initially limited to just 'el' (with and without an article). Then it expanded to "on the tracks" (which, like the trolley wires in the cartoon episode he was describing, are overhead in an elevated train system). A full sentence with a single clause then emerged ("he saw the el train"), and finally, dramatically, considering the depth of his initial agrammatism, a full sentence with two verbs and clauses ("he saw the el train comin'"). The example illustrates a catchment (the overhead wires/tracks, no apparent metaphoricity) and under its spell a step-by-step accessing of a construction. The duration of the catchment and the time it took to reach the final construction was two minutes and seventeen seconds.

In terms of our brain model, Broca's aphasia, true to its name, is a breakdown of GP unpacking in Broca's area. The area normally orchestrates vocal and manual actions with significances other than those of the actions themselves. Consistent with such a breakdown, recent reports state that Broca's aphasics have difficulty recognizing other people's actions (Fadiga, 2007). This can be regarded as the perceptual equivalent of impaired orchestrating capabilities. On the other hand, processes said in the model to be carried out elsewhere in the brain, the posterior left hemisphere, the right hemisphere, and the prefrontal cortex—imagery, the combination of imagery with linguistically encoded categories, and the relating of all this to tailor-made fields of oppositions, as well as prosodic emphasis on the linguistic realization (cf. Goodglass, 1993)—appear intact, evidenced in the continuing ability by agrammatic speakers to synchronize co-expressive speech and gesture, and to differentiate contextually newsworthy information with them.

Down's syndrome

Downs's syndrome (DS) is characterized by a linguistic disability beyond what an also-present cognitive disability would predict. DS children lag in language but are relatively spared in visuo-spatial and visuo-motor abilities (Stefanini, et al, 2007). It is not surprising therefore that DS children show a 'gesture advantage' (also called 'gesture enhancement')—a preference for and receptivity to gesture over vocal speech, a phenomenon first noted by Abrahamsen, et al (1985) with taught signs and words. A gesture advantage has also been observed with spontaneous gestures during naming tests in recent studies at the Institute of Cognitive Science and Technology (ISTC), in Rome, part of the CNR. However, in this situation, unlike Abrahamsen et al.'s findings with signs, DS children do not show gesture enhancement at the one-word stage; enhancement emerges only after the children reach the two-word threshold. DS, the ISTC finds, display a significantly smaller repertoire of representational gestures but produce them with a frequency equaling that of typically developing (TD) children (Stefanini, et al., 2007). In picture naming, DS gestures are semantically related to meaning in the picture, and so can convey information even if there is nothing corresponding to them in speech. These 'unimodal' messages suggest a mode of information processing fundamentally unlike that of the typical GP. Ultimately, according to Abrahamsen, et al, the gesture advantage weakens and disappears with the emergence of syntax. So it is a transient phenomenon of development, emerging earlier with taught signs than with spontaneous

gestures, and eventually disappearing or reducing in size with the establishment of some kind of syntax.

Typically developing children also show a gesture advantage at early ages, but with two crucial differences: unlike DS, the gestures of TD combine with words to encode semantic relations, whereas for DS the word-gesture combinations tend to be redundant. Secondly, the gesture advantage with TD occurs *before* the two-word threshold, and in fact reliably predicts when and with what semantic relations this threshold will be crossed (Butcher & Golodin-Meadow 2000, Goldin-Meadow & Butcher 2003). These differences, when examined, shed light on the nature of the DS linguistic deficit itself.
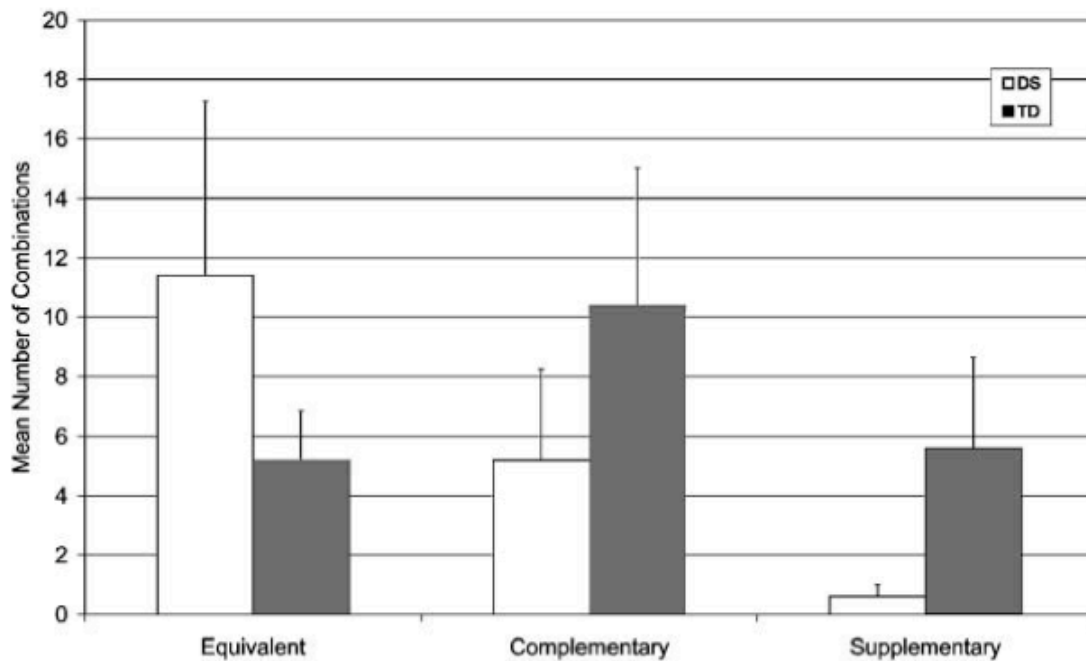

Fig. 4. Information conveyed in gesture + word combinations by Down's Syndrome and mental age matched Typically Developing children (Iverson, et al, 2003; used with permission).

What is impressive about DS, revealed by work at the Rome Institute, is that DS gestures are often 'unimodal', as noted, and, further, that when they occur with speech they are mostly *semantically redundant* with the accompanying speech. What does this imply for GPs? The chart in Fig. 4, from Iverson et al. (2003), shows that the predominant gesture-speech combination in DS (white bars) is 'equivalent' ('redundant'), in contrast to TD (dark bars). Volterra, et al. (2005: 29) say of this: "[w]hen children with DS combined gestures and words, they did so primarily in an informationally redundant fashion. The vast majority of combinations produced by these children were in fact equivalent combinations in which the two representational elements referred to the same referent and conveyed the same meaning (e.g., headshake for no = 'no')."

In TD, on the other hand, early speech-gesture combinations are 'complementary' (partially redundant gesture and speech referring to the same object but different aspects of it, which DS also create, though far less than 'equivalent') and 'supplementary' (non-redundant, gesture and speech referring to different entities in some kind of semantic

relation, like POINT AT CHAIR + "daddy" = 'daddy's chair', possessive, which DS create virtually not at all).

Goldin-Meadow & Butcher (2003), with TD children, classified the semantic relationships in speech and gesture combinations, and found that speech-gesture combinations foreshadowed the child's first word-word combinations, these appearing a few weeks later with the same semantic relationships. A child who pointed at an object and said "go" would, a couple of weeks later, produce word-word combinations with "go" plus object names. The early gesture-word combinations cover a range of semantic relations: "open" + points a drawer, "out" + holds up toy bag, "hot" + points at furnace, "no" + points at box, "monster" + two vertical palms spread apart (=big) (Goldin-Meadow & Butcher, Table 3). Kelly (2006) observed an earlier step, in which the first pairings involve gestures and speech that denote the same elements; it is only slightly later that different speech and gesture elements synchronize to form the semantic units described by Goldin-Meadow & Butcher.

Thus TD children begin with a gesture advantage, first with redundant gestures and speech, then with semantic combinations of gesture and speech foreshadowing the same semantic combinations a few weeks later in speech-speech. DS in contrast appear to take only the first step. Even their 'complementary' gesture-speech combinations are a species of redundant combination. It is only 'supplementary' combinations that combine semantic elements into structures that foreshadow combinations of words, and DS lack these almost totally.

To understand these differences in GP terms, we note that redundancy and exclusion of semantic connections between gesture and speech suggest that DS growth points, in whatever form they exist, are narrowly constrained. The opposition of semiotic modes within these narrow limits would give them little traction. The type of example in Fig. 1, in which the underlying idea of Sylvester moving up inside a pipe is symbolized in two semiotically opposite forms, may be beyond their reach. Imagining them recounting this episode, they may say "pipe" and gesture its shape; or "sidewalk" (where Sylvester paced before going up the pipe) and gesture a flat surface; or " ball" and make a circle; but not "rising hollowness" or even "down" if, as we suppose, the Fig. 2 aphasic speaker was differentiating the idea of downward force in a context of things that Tweety and Sylvester were doing. In DS, this apparent narrowness in turn could impact the dependence of the GP on fields of oppositions. DS growth points, redundancy welded, would differentiate only equally narrow contexts where synonymy of gesture and speech is meaningful. Verbalized thought, for DS, would then be confined in at least two ways—growth points with little dynamic push, and contexts cramped to make minimal differentiation significant: in this way coming up short on the dynamic dimension of language. Their dynamic shortfall joins the deficits on the static dimension of factual linguistic competence (where naming and syntactic deficits are noted). The aphasic speaker who after two arduous minutes reached a two-clause, embedded sentence was sustained throughout by his spatially configured catchment (observable in gesture), and this kind of achievement, and any benefit of catchment formations in general, may be largely out of reach for a DS speaker. Finally, a lack of GP semiotic opposition could impair the unpacking step, limiting access to constructions, even if they have been acquired. So the picture is of limited GP potential, lessened dynamism of thinking-

for/while-speaking, limited contextual scope, and limited potential to form gestural (catchment) discourse segments. Bellugi, et al. (1994) describe older DS responses to vocabulary tests as often involving perseverations or category errors (e.g. "horsie, dog, ice cream" to one picture), which also seem to be manifestations of cognitive narrowness.

Given that DS speakers have comparatively good visuo-spatial and visuo-motor cognition, the shortcomings we describe refer specifically to GP formation. Our suggestion is that DS start out with gestures preferentially; in this they are not unlike TD children in the second year. But they differ in that, when they add speech, the speech-gesture combinations are redundant, totally or partially. As such, speech-gesture combinations fail to carry the DS over the language threshold. So if normal development involves gesture as a way station toward language, DS development seems excessively stuck at the level of redundant gestures.   It is telling that the gestures they do produce, after considerable experience, are also not ones likely to foster semiotic oppositions with linguistic encodings. Volterra et al (2005) offer an interesting suggestion: "…children with DS may be able to make use of actions produced in the context of object-related activities and social routines as communicative gestures. Once this happens, they may begin to develop relatively large repertoires of gestures and make enhanced use of gesture to compensate for poor productive language." (p. 32). These kinds of compensatory gestures are the not co-equal participants with encoded language with which to create the semiotic oppositions a GP demands; in fact, such gestures are substitutes, and doubly so—not only for deficient language, but also for deficient gestures (cf. Chan & Iacono, 2001).

Williams syndrome

Williams syndrome (WS) is often pictured as the mirror image of Down's syndrome. WS children have cognitive deficits, IQs in the 50-70 range, yet seem to have *greater* language skills than the cognitive deficits would predict. They are also highly socially engaged, musical and lively. Social engagement and musicality we think are the keys to their language as well.

WS poses an interesting challenge to the GP theory: how, given the theory, can language go beyond cognition's offerings? The seeming sparing of language has made WS the poster child of purported language modules. However, from a non-modular GP perspective another interpretation seems possible. We shall answer the challenge in the following way. Although it may seem perverse to refer to better-than-predicted language as a 'disorder' we shall in fact conclude that, in the WS case, good language arises from disruption of the GP, namely a disconnect between the social framing of thinking-for-speaking, of which WS clearly are capable, and what Vygotsky (1987) termed pure thought. Gesture mimicry and other forms of mind-merging participate in constructing social interactions (Kimbara, 2006), and we believe that WS children have similar capabilities. In effect, WS speakers maintain the connection of idea units, GPs, to the social context of speaking, via what is sometimes called 'hypersociability' (Bellugi et al, 1999), creating joint GPs with interlocutors (as unimpaired speakers also do), but are unable to shape thought outside the social fabric, and this is their disorder. Vygotsky visualized thought and speech as overlapping circles, one for thought, one for speech, and the overlap was inner speech; the GP is a theory about this overlap, and what we propose

for WS is truncation or inaccessibility of the thought circle from the overlap. The result leaves little room for the GP to shape cognition—the reverse of trying explain how cognition affects language: it is cognition in WS that is not shaped by the ongoing thinking-for-speaking process.

If this is on the right track, WS is thus a disorder of the dynamic dimension of language *par excellence*. Language is weak at shaping cognition, while it retains what is also usually integrated with thought, the social-interactive fabric. There is a distinctive gesture profile of WS, in which only certain kinds of imagery take part: iconic gestures and a plenitude of socially constituted 'emblems', if available in the culture, both of which are engaged in social interactions, but also an absence of gesture metaphor with meta-discourse resonances. An interpretation of WS in terms of our proposed brain model is far from certain, and we do not attempt it, other than to suggest that among the unique qualities of WS GP formation is an energetic rhythmicity, which can underlie both their fluency of speaking as well as the other quality of the syndrome, musicality. The role of the cerebellum in organizing rhythmic pulses of speech (Duncan, 2006) is echoed by the discovery of hyperdevelopment of the cerebellar vermis of WS, thought to underlie rhythm (Schmitt, et al., 2001).[9] These rhythmic pulses obviously engage their musical lives but also can play into sociability, underlying the entrainments of the children with social others during interactions (cf. Gill, 2007).

It has been said that WS are slow to develop gestures (Volterra et al. citing Bertrand et al., 1998), and that their gestures, when started, are not frequent (Laing et al, 2002), but other studies at the ISTC in Rome have observed no difference between TD and WS matched for developmental age (Volterra, et al, 2005). In their recent work, with 9-12 year old WS children, researchers at the Rome Institute find WS perform gestures in picture-naming and Frog Story narrations at a *higher* rate than TD children of comparable developmental ages, have *more iconic gestures* and *more pointing gestures*, and *combine gestures to a greater extent with 'social evaluation devices'*, such as character speech, sound effects, exclamations, and rhetorical questions that function to capture the listener's attention (Bello, et al., 2004; Capirci, 2007). More precisely, they found a significant correlation between total spoken social evaluation devices and the use of gestures only for WS children (p= 0.0078). A significant correlation was found in particular with iconic gestures (p= 0.0001) and beat gestures (p= 0.004). Those children with WS who produced more gestures (in particular more iconic gestures and more beat gestures) were also the children who produced more spoken social evaluation devices.[10]

We get a picture of WS children as socially interactive, with gesture a well-established modality for human interaction. Their 'enhanced language' we propose, stems from this lively social engagement, as described above. This implies the GP in the following way. Vygotsky, in his reanalysis of egocentric speech, argued that a child's development is from the outside, the social context, to the inside—the once-social becoming thought. This ontogenetic process has an echo on the much tighter time scale of GP microgenesis, in that the field of oppositions includes, among other information, social interaction variables and the GP itself can be shared interpsychically (cf. McNeill et al, in press, for

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[9] Interestingly, children with infantile autism show the reverse, reduction in posterior cerebellar vermis volume (Courchesne, 1994).

[10] We thank Virginia Volterra and Olga Capirci for emphasizing these points.

descriptions of 'mind-merging' in normal adult conversations). We suggest that WS have GPs of this kind. This is not only mimicry; speaking can be self-generated but depend for sustenance on continuing social interactions; closed off is self-directed thought carried by language, including metaphor. Distinctive about WS thinking-for-speaking is its dominant social frame assisted by rhythmic entrainment. Cognitive deficits, including relative inability to access the semantic values of words (Karmiloff-Smith, et al., 2003), may deflate the thought circle, but sociability is the key to their language. In this sense, the skill of WS children in language is an aspect of the disability.

However, the facts of actual WS language ability are less than totally clear. In keeping with their sociability and rhythmicity, speech flow is impressively fluent. But the depth of WS language skill is debated. On the one hand are those who argue for near-normal language abilities. Zukowski (2001), for example, compared WS and neurotypical children's language production data on noun-noun compounds, embedded relative clauses, and yes/no questions; also grammaticality judgments of uses of expressions with 'any' and 'some'. She found performance in the two groups to be similar, concluding, "WS is indeed highly relevant to the modularity debate. The findings also suggest that imperfect levels of language performance in WS may reflect an exaggerated influence of normal processing factors" (from the abstract). On the other hand, Karmiloff-Smith, et al. (2003) summarize numerous tests of WS, concluding that "…the WS language system is not only delayed but also develops along a different trajectory compared to controls, with individuals with WS placing relatively more weight on phonological information and relatively less weight on semantic information" (p. 230). Karmiloff-Smith, et al. are emphatic in their rejection of innateness linguistic 'modularity' claims based on spared WS language skills in the absence of general cognitive ability (cf. Pinker, 1999), citing both the relative inaccessibility of semantic content to WS, and also tests of sentence comprehension, which show "…findings inconsistent with the view that WS syntax is intact" (p. 231). In thinking about the modularity issue, it is important to recognize that no general principle relating a given level of cognitive ability or inability to a specific grammatical form presence or absence has ever been defined; so an ability to produce relative clause responses in experiments, for example, may or may not count as evidence of a syntax module, particularly if (as Karmilof-Smith et al. propose) WS children reach these abilities over different developmental routes (which may include tracks, not seen in typical development, linked to their hypersociability). And again, in general, sociocentric inputs may create an illusion of structure.

Social framing can also create an appearance of narrative cohesion. Bellugi et al. (1994) observed an abundance of "paralinguistic and linguistic devices for expressive purposes and to maintain audience interest" (p. 16); that is, a cohesion based, not on thematic linkages in discourse, but on the continuation of purposes in social interactions. We can predict that, despite their better than expected language and gesture output, gesture catchments from WS will tend to emphasize this kind of sociocentric cohesion, with few if any catchments built out of recurring gesture references, as we saw created for example by the agrammatic speaker in Fig. 3.[11] Social but non-referential catchments may thus

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[11] This refers to catchments, not mere gesture repetition; that is, recurring gesture features that mark off a discourse theme (we have found no information bearing on whether WS do or do not repeat gestures).

be another aspect of the WS syndrome. It is possible that in WS there is an absence of discourse awareness itself (cf. Sullivan et al., 2003, for WS inability to distinguish lies from irony, where doing so required relating verbal uses to context in comprehension).

To summarize, using Vygotsky's image of overlapping circles, the WS thought-circle is flattened (Fig. 5)

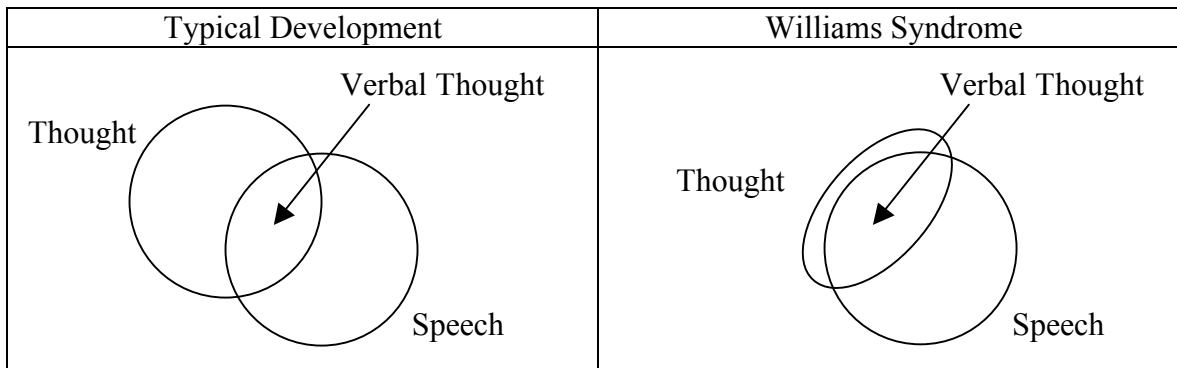| Typical Development	Williams Syndrome

Fig. 5. Representations in the manner of Vygotsky (1987) of the relationship between thought, speech and verbal thought, in typically developing and Williams syndrome children.

Childhood autism

Elena Levy (in preparation, 2007) has developed a method by which to observe the emergence of spoken discourse cohesion over short intervals—short, but extended enough to permit observation of emergence. A child is shown a classic film, *The Red Balloon*, and tells the story to a listener. Specific to the method is that the child tells the story repeatedly, over several days (sometimes on the same day), to the same or different listeners. In this way, changes, which typically are consolidations that enhance cohesion, can be tracked as they emerge. The method can be employed with speakers of all sorts and has been used by Levy with autistic children. We concentrate on a case study of a 13 year-old boy. While many differences from typically developing children are found with autistics, we focus, following Levy, on the catchment and its theoretical role in creating fields of oppositions. In his first attempts at retelling the story speech was fragmented and gestures few, responses were "…single utterances or utterance fragments, usually in the absence of focused enactment, and often accompanied by diffuse body motion, for example, shifting position, swaying back and forth, rocking, and fidgeting" (p. 5 ms.).

Levy documents that from this point fully encoded descriptions gradually emerged and—equally striking—also gestures that look typical for such speech; in other words GPs in what appear to be appropriate fields of oppositions. Coherence increased via catchments: "As D. combined speech with enactment…he created a sequence that was more temporally coherent than the first: All utterances were accurate descriptions of events, and all occurred in accurate temporal sequence" (p. 11 ms). An example analyzed in detail by Levy involves two catchments at early points in the child's narrative attempts—*flying* gestures, and *holding* gestures—that resulted eventually, after several retellings, in a correctly narrated sequence of events (corresponding to the film's sequence). As fields of oppositions, we can see in these catchments how the narrative order was finally straightened out. Initially, the boy first described flying with balloons, then, immediately

following, holding onto the balloons (while reversing the film order, the order of D's utterances is the same as by the adults when first prompting the scene). Then the following (Table 2, based on Levy, p. 23 ms.):

Table 2. Achieving discourse cohesion by an autistic adolescent

Narrative order	Speech	Gesture	Field of Oppositions something like:
1	he floated	start of holding gesture	What Happened While Holding: floating
2	he hanged on tight	continuation of holding gesture	Still What Happened While Holding: holding tight
3	[no speech]	flying gesture	The Thing That Happened: flying

Based on Levy, ms.

Although starting out with an airborne reference, again out of sequence, he had the holding gesture in the correct narrative sequence (holding first). The GP at this point would be as suggested in the table: differentiating what could happen while the boy was holding—floating. The child continued with the correct sequence: holding followed by flying. Achieving temporal coherence thus stemmed from catchments and the realization, eventually, that the holding and flying catchments interrelate, one continuing what the other began. This is a kind of imagery-enactment version of the logical relationship of an enabling cause/resultant, which the boy could achieve in this form even if not with a clear vision of the logical connections themselves.

From a GP point of view, as exhibited in this case study, autism seems to involve an imbalance between enactment and speech which was overcome with repeated telling. Like the aphasic in Fig. 3, a catchment emerged accompanied by coherence (they differ of course in that the autistic child recycles entire descriptions, whereas the aphasic took time to create a single description). In the brain, we speculate, the imbalance focuses on the pre-frontal and motor cortexes, with the latter at first flooding the former. The awakened pre-frontal area is energized and creates something like a normal field of oppositions. In cyclic retelling there is something that activates and/or restores balance across brain regions and leads the autistic speaker toward the realm of the typical. We can imagine that autistic children might seek this kind of cyclic activation on their own— some of the repetitious behavior often remarked upon in the disorder may be an effort to overcome enactment imbalance. At the same time, however, such an effort is a recipe for impaired social communication. What, for an autistic child, may be an effort for eventual enhancement is limited if not actually counterproductive as a kind of social foray. Thus the child would be denied the propulsion from socially engaged cognition that carries WS children so far.

Summary and conclusions: What the GP shows

We began this chapter saying that the four language disorders—agrammatic aphasia, Down's syndrome, Williams syndrome, and autism—disrupt different aspects of the GP. We conclude by summarizing the disruptions and what they reveal about human speech and its points of possible breakdown. We suggest that a GP view of language shows the disorders in new light. For this reason, we believe, it is worthy of consideration by clinicians and researchers who deal directly with communication disorders.

Disfluent (agrammatic) aphasia preserves the psychological predicate character of the GP, the point of newsworthy information differentiated from context. Context and catchments are accessible. The aphasia concentrates specifically on the unpacking of GPs via constructions or other syntax. Constructions may also be intact, in part, but are impeded due to shallow level motor impediments interacting with the vocal articulators. The evidence for this is that, with catchment support and sufficient time, agrammatic aphasics can develop even multi-clause unpackings. It is accordingly easy to understand the frustration sometimes shown by agrammatic aphasics, since they experience basically the whole process of thinking-for-speaking but cannot execute it in action. Autism reveals an imbalance of enactment and catchment formation that, with repetition, can be overcome; so the disorder is one of balance, not specifically a breakdown of the growth point. In contrast to the aphasic, once balance is reached, speech and discourse appear to function with something like normalcy. Down's syndrome speakers, children at least, may not experience thinking-for-speaking in anything like the form it is encountered by normal speakers, the autistic child, or the agrammatic aphasic. The elements opposed semiotically in their GPs are redundant, there is little scope for cognitive movement, and the contexts from which these rigid GPs are differentiated are comparably narrow. The impression one gets of Down's speech therefore is of stasis, immobility, and little potential for fueling thinking-for-speaking. Williams speakers unusually seem to have half the normal complement of thinking-for-speaking, missing the other half. Their GPs are socially engaged but do not pass into thought, possibly because their cognitive deficits prevent it. Down's and Williams syndrome speakers are mirror images in respect to thinking as well; both are unable to use language as an enriching element of cognition but for opposite reasons—Down's cannot break out of limited GPs; Williams cannot translate GPs structured as lively social interactions into cognition.

A further dimension of comparison involves the place of the catchment in the four disorders. Disfluent aphasia retains at least the capability of thematic linkages with spatial, deictically established catchments, as we see in both Figs. 2 (correct deictic placement of the bowling ball placement) and 3 (the overhead locus). Autism initially cannot form catchments but attains them with appropriate enactments, as in the flying example. This may limit their discourse cohesion to the enactable, just as the aphasic's may be so limited, with no or little potential in either case to extend imagery metaphorically. Down's Syndrome, because of the near-total redundancy of imagery and speech, probably cannot form catchments at all. Each image is tied to a specific lexical form. Finally, in Williams, we may find catchments (if sought) based on social interaction, and these catchments could be the richest of all, since interaction can lead the child into complex and enduring forms of cohesive discourse. In respect to catchments, WS and autism differ diametrically. Autistic social catchments may never be reached if

recycling is the route, since it is so disruptive to the normal parameters of social interaction, whereas, in WS, where hypersociability is the style, such catchments might be the starting point of almost all of their speech.

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