Why I am (still) a sociocomputationalist
and why you should be, too!

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I am flattered by the selection of my 1997 book for debate in this prestigious journal, and I am grateful to the editors for devising such a useful, ongoing conversation about questions that many of us take to be the driving ideas of our intellectual work:
- *What is thinking?*
- *How does thinking relate to language and the social world?*
- *Does history matter to thinking or to explanations of thinking?*
- *How can we connect the latest models of thinking and language with the valuable insights of those on whom we build our theories, even those with whom we disagree?*

A confident answer to any one of those questions –or even a part of one of these questions– should keep us all happy for the rest of our lives. But I am even more humbled by the fact that I am familiar with the efforts of a number of the commentators to answer questions such as the foregoing, and my great respect for their views tempers further my partial answers to our shared paradigmatic questions.

Responding to the commentators, however, poses an enormously difficult task. To reach back to them in the ways they have thoughtfully engaged my book is simply not possible because of the amount of time that has elapsed between now and the appearance of the English version of *Vygotsky and Cognitive Science* (which was completed, for all intents and purposes, in 1995). In the near decade since, computationalism has changed, Vygotskyanism has changed, I have changed, and, I would guess, even in the two years since these initial commentaries, the views of the commentators have changed. To do the whole context justice, I would have to engage each commentator one by one and update their arguments and mine. In other words, I would have to write the next book!

So I have had to circumscribe my response. Let me say as a way to begin that Gabucio's summary of my book is excellent: it is accurate and thorough. Among the commentaries, there are some authors with whom I think I see pretty much eye to eye: Domingo and Igoa, e.g. There are others whose arguments I understand, but simply disagree with –hopefully not irreconcilably: Rosa, e.g . For many others, I am grateful for their corrections. I am especially thankful to those who pointed out translation errors. I did not see the final Spanish version before publication and so was unable to exercise any editorial control over the style and accuracy of the translation. And yet there are others whose arguments

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partly remain mysterious to me –some of what Vera says, e.g., escapes me even after numerous readings. To invoke Wittgenstein, I pass over them in silence.

I have organized my response into two sets of issues:

• those that clarify my argument and have caused commentary, consensus, repartee, and genuine distress.

• those that point beyond the 1997 book to what, in my view, would be a productive, future Vygotskyan cognitive science.

Clarification of the argument

While some commentators have occasionally accused me of secretly holding a defective expansionist theory, in truth I had a quite limited purpose in *Vygotsky and Cognitive Science*. I sought to explain the place of (what I understand to be) the core of classical Vygotskyanism in classical computationalism. My argument was that social speech goes underground in the service of metathought in problem solving as individuals establish identities by differentiating from the external social world (classical Vygotsky), and this speech has a computable form and function in the control mechanisms of the mental-computational architecture (classical computation). Because of this convergence between inner social speech and computational control, computationalism and Vygotskyanism can be mutually informative. I called this whole effort *socio-computationalism*. In retrospect, my mathematical side, pressing me to say precisely and only what I mean, insists that I should have labeled the idea *historico-socio-cognitive-executive-mechanistic-computationalism*. This is a wonderfully accurate term that cannot be uttered!

In spite of –and because of– the commentaries on my proposal, I remain certain that this view is correct. In fact, I am even more convinced that anyone who believes in social mind (as I do) cannot avoid embracing this view as well as other computationally tractable varieties of social mind.

Computationalism

When it comes to mind, *there is only computation*. The concept of computation is neither a vague metaphor awaiting materialistic rephrasing nor an extreme reductionistic view. Mind *is* computation. There are no mental processes that are not in some form computable, and processes that are not computable cannot be candidates for mental explanation. I once heard a colleague offer the following explanation for why adult second-language learners reach limited competency: the learners simply decide to stop learning because they see that what they have learned is enough for them to get along. Fair enough! But how do they do that? Phrased in the way it was, such a statement is not a claim about thinking, but about phenomenology. To be responsible mind theorists, we must ask, «What mechanisms make this a way to talk about the decision and behavior?». The answers to this must yield computable (in principle) mechanistic descriptions –even for the fuzziest and squishiest things, like beliefs, feelings, desires, selves, and so on.

A popular materialist apothegm to which I adhere goes: *No matter? Never mind!* I would add, *No execution of functions over representational states? Never historico-socio-cognitive-executive-mechanistic-computationalism!* For me —and, I would dare to assert, for you— computation is the only way to explain mind. Domingo, Igoa, Rosa, Vera, and Madruga must all be either pleased or angered by this claim. What does it mean?

Suppose that you believe that a thought is like a fossil and is explained only by reference to history, as Lacasa argues. By *history*, I gather we mean something like «events linked in time with significance to someone», not just things that happen. For events linked in time with significance to someone to have a role in mind, the significance must be translated into something that can be taken up by a mind in its actual decision processes. Or, as I said in *Vygotsky and Cognitive Science*, the external world must have a representational landing site in a thinking device. Thus, situated cognition is not a theory of cognition in any way, shape, or form, unless the situated information is cognized. This seems to me so obvious as to be axiomatic.

Imagine that a culture's history of solving problems in certain ways is somehow indexed in the culture's language –e.g., in lexical meanings or, more likely, in the meanings of certain grammatical functors at the boundary between discourse and syntax. What would it be for such an intrinsically historical claim to be tenable or even testable –beyond a metaphor itself– as a claim about thinking? There would have to be a way for this cultural history to inflect individual mind in actual instances of operation. That is, these forms in their historical semantic richness would have to be demonstrated to evoke the historical facts and actually be used by minds in problem-solving tasks. If history is in mind, it has to be run on a mind. But if history remains external to mind, it may be an interesting and useful set of facts to inventory and investigate, but these facts would be best described and explained by anthropology, sociology, journalism, or whatever, not mind theory. We must be careful to make a distinction between history merely having some bearing on mind and history entering into the explanation of mind. For the latter, it must be computable.

I believe that mind is historical, as Vygotksy did. That is, I believe that mind is a fossil and that any purely synchronic, surgically removed piece of mind cannot be fully understood except in terms of its history (which is why I think that evolutionary psychology has some useful convergences with new Vygotskyanism: see below). But I also believe that unless we demonstrate how and where history appears in mind, we have made an empty claim by saying *all behavior is the history of behavior*. All physics is the history of physics, too, in some sense.

A proper understanding of the role of history in thinking allows Vygotsky and cognitive science to sharpen each other. When you explain a thought process, your account must be tempered with a historical claim. For example, is the likelihood of retrieval of certain lexical memories a probabilistic function of past retrievals or past activations? Obviously, yes, for some lexical forms: this is the essence of connectionism. Is the likelihood of retrieved episodic memories a function of the individual's position in the external episode as retrieved over

time, or of the way that the culture has organized those episodes, perhaps in language? I have no idea, but this would be an intriguing idea to test, especially if language somehow indexes episodes for retrieval. Consider some evidence. According to Schrauf (cited in Carruthers 2002), it is easier for bilinguals to construct a memory in the language they would have been using at the time of the episode to be recalled than in the other language they speak, not because the memories are fully constituted by the language, but because the different languages are indexed to the memories in different ways. Such a finding seems to me to be ripe for being molded into support for two Vygotskyan claims: language plays a role in on-line thinking, and the history of behavior helps explain current behavior. Moreover, this finding can also be recast into computable form through some sort of propositional or schema-theoretic representation and historical-linguistic indexing on its retrievability. Vygotsky now begins to make computable sense.

For me to believe that mind is historical, you have to show me how history is actually used by people in their mental activities –not as a mere backdrop to thought, but as an element of computable mind. A lot is part of the influential backdrop to thought– the surface of Mars, my mother's illness, Poland's wars. But saying that historical events have a bearing on mind is not the same thing as saying that mind uses them or that mind must make reference to them to work.

How does mind use such things? It can use them *only in computable form*. History and society, too, must be computed. All accounts of mind, as far as I can see, are computational. Classical symbol processing, connectionism, dynamic cognition, situated cognition, schemas, scripts, frames, quantum computing, etc. –these are all computation. That is not to say that they are explicitly computational themselves: only that their claims must be phrasable in ultimately computable terms. Nor is it to say that mind is a computer. All computers compute, but not all computing needs a computer. Computation is the *execution of functions over representational states*, and this process can be implemented in a wide range of material, but material is needed. Even the irrepressible Gibsonian theory of affordances, where shallow minds run around in a rich world that does most of the work for them, has to have computable uptake: affordances for whom? for what? in what form do they afford anybody anything? Computation may be shallow, minimal, probabilistic, associationistic, or whatever –but computation it nonetheless is. Social mind is a computational state.

Another way to say all this is that psychology is about mind, and mind is what brains do when they compute. (So I reject Rosa's claim that I am a dualist.) Society is not what brains do. Only a thought-society is what brains do.

I now see, as I hinted in my book and stand corrected by many of the commentators, that sociocomputationalism is principally a claim about cognitive science –or that cognitive science wins more than Vygotsky in this competition. This is true, and it happens because cognitive science is to thinking as what evolutionary theory is to biology –the unifying metatheory that allows all other claims to make sense. A theory about social mind, as well as one about emotion, culture, or mathematical thinking, must comport with cognitive science to be believable and testable, in the same way that biological claims are sensible only

against the backdrop of evolution or physical claims sensible against a theory of cosmology. Consequently, when some commentators suggest that I am talking about Vygotsky and cognitive *psychology*, this is a serious misunderstanding. Cognitive science is the metatheory of all mind science, including cognitive psychology, which itself has to be made compatible with cognitive science. There remains to be written an interesting book called *How Cognitive Psychology is and is not Cognitive Science*. Just like Vygotskyan socio-historical cultural psychology, cognitive psychology is a branch of cognitive science and must also be computational.

So, indeed, Vygotskyanism and all proposals about mind have to be made computational to be sensible as descriptions or explanations. This leads to the claim that I am really siding with computation over social. I concede the point: I think this is true in a metatheoretical sense. And perhaps a better title for my book would have been: *Vygotsky in Cognitive Science: How One Version of Sociocultural Psychology Can Reach Explanatory Adequacy*.

My ultimate computational leanings also lead to various commentators to suggest, as counterpoints, that some aspects of mind are not amenable to computationalism. Various responses invoke dynamism and call for flexibility and emergence. Vygotsky is added to this mix in two ways. One is to say that because Vygotskyanism involves dynamic cognition, it can't be computational; the other is to say that if Vygotskyanism is at all computational, it must be through connectionism or some other dynamic model, not the kind of symbolic computation I advocate (where control makes sense). I think both these strategies are incorrect.

Here is an idea that I hear in a variety of forms and which I consider patently false:

> Thinking is dynamic through and through, with the mind in constant update and adjustment to input and its own mental loops. This intrinsic dynamism means that mind has no, or a very limited, fixed base and so there can be no computational theory of mind in the long run. Dynamism and emergence exclude the fixity of classical computation. Vygotsky fits in as a counter to fixity theorists because of his dynamism: social mind is in constant update, etc., etc.

I don't believe this at all (nor did Vygotsky, as far as I can see, since he advocated at least three levels of mind, the lowest quite elemental and «fixed»). The dynamist's complaint is a sort of existential denial of computation, occasionally bolstered by a false grasp of quantum computing (where all is supposed to be in flux: show me how we get stable beliefs about society from an unstable, quantized, material substrate, and then I'll begin to believe such claims). If thinking is *totally* dynamic, then there are only individual instances of thinking. Consequently all our claims about regularity and expectation and all Vygotskyan observations about the predictability of social semiotic supports to thinking go out the window. There can be no science of one-time events and hence no science of mind built on complete dynamism. I recall hearing at an international socio-cultural conference the claim that even genetic disorders are variable and socially constructed. What an irresponsible proposal driven by ideology alone! Tell that to

the parent who of a child with Fragile-X Syndrome: fix the society and we'll fix the genetics? If social mind is radically uncertain, and things like *self, emotion*, and *person* are therefore not amenable to precise computational formulation, then we are left with ethnographies and individual histories. If this is what a commitment to dynamism gets us, then responsible thinkers must opt out.

It seems to me that history is made up by people in a regular way and, along with a society, is a stable semiotic support developed by humans as a resource and taken up in the representational devices inside the head (probably driven in large part by language). This is an efficient way to do mind business. How inefficient to reinvent the rules every time you think! Neither nature nor humans make things again and again, but establish some fixity on which subsequent things are made: mind has a stable substrate, admitted by even in the most dynamic radical connectionism (read closely the first part of the supposed counterculture articles of faith: *Rethinking Innateness*). The most dynamic mind has computation. This is because you can't have mind without matter, and the way the matter of mind works is through organized computational states.

Here is another idea that I hear in a variety of forms that I also consider patently false:

> If Vygotsky is to be made computational, then connectionism is the only way to do it. This is because connectionist models are the most brain-like, are non-deterministic, and adapt easily to the outside world. If not connectionism, then some form of dynamic systems modeling is best.

Maybe. For one thing, it is not at all clear that connectionism is a realistic rendering of mind-brain processes: no brain executes back propagation, e.g. For another, there are certain essential mental phenomena, such as variables, that a neural net cannot represent (Marcus 2001). So if Vygotsky comes to rest in cognitive science via connectionism alone, then we need to think harder about Vygotsky's computability. Let me give you an example.

For inner speech to be a part of mind, it must be abstract and constituted in some sense by variables. That is one of the advantages of Vygotsky's observation that inner speech is predicative: it has a logical form that allows it not to be reinvented with every instance of problem solving; inner speech is a resource that a mind is equipped with and that can be called up in on-line thinking. For this reason, as I have said in many places, the forms that surface in private speech are always logical predicates, never functors. Thinkers in the act never say to themselves: *the, the, the*, but *red, blue, go*, etc. As a computable function in running mind, inner speech uses predicates, which are variables. That is, the mind says to itself: it is one of *those*! Mind makes types. Unless connectionism can handle variables, it cannot handle inner speech. Marcus (2001) convinces me that connectionism cannot handle variables. Therefore, because an essential feature of Vygotskyanism requires variables – the predicative structure of inner speech –the best cognitive science for Vygotskyanism is one that has mind as a symbolic computing device. Indeed, variables are a way of capturing fixity and dynamism at the same time, which to me what Vygotsky (and Wittgenstein)

all about: how can dynamic, socially connected, individual mind run on an abstract base of stable resources?

Other Sociocomputationalisms

A number of commentators offer ways other than what I have proposed to bring social mind and, presumably, Vygotsky along with it, into computation. These proposals advance potentially computable or formal-like theories, such as mental models, situations, schemas, and executive control, as alternative and rather well-developed varieties of sociocomputationalism that complement or substitute for my brand of Vygotskyanism (see, e.g., Siguan, Rodrigo, Domingo, and Gomila). I agree mostly with these proposals, but find them orthogonal to my main point.

Let me repeat that my goal in *Vygotsky and Cognitive Science* was to take what I believe to be classical Vygotskyanism and show its computational viability. The view of Vygotsky I am working with is as follows:

> In the course of human development, social dialogic speech, which is the principal reflection of external semiotic supports to thought, is reduced and goes underground as monologic inner speech, intertwining with thinking (hence «speaking and thinking»). Social speech then surfaces wherever semiotic support for thinking is needed –e.g., in difficult on-line tasks– as private speech. The origins and course of this speech-mind development are a unique feature of Vygotskyanism. Humans are born social and must learn to use the speech of others as a resource and means for them to individuate into self-regulated thinkers. Linguistic relativity and cognitive variability, the unique socially-thinking person, the effects of history on individual thought –these are all bound up with and secondary to the process of the «speechification» of thinking.

There are certainly social structures that humans represent in their computational minds as schemas and scripts. But how does speaking connect to these? How are these semiotic supports translated into speech for thinking? To me, these are the specifically Vygotskyan questions.

There are certainly mentally represented social situations that can be computed as propositions or image schemas. Wertsch's wonderful, detailed microanalyses reveal how different situation definitions determine courses of behavior. How does the language of the situation –perhaps determined by the different languages in which the situation is enacted– drive (perhaps differentially) the regulatory mechanisms that allow an individual to successfully complete a task, from others' help to solo performance? These are Vygotskyan questions.

There are certainly mental models, ordinary logical models serving problem solving and reflecting contingencies of the social environment more than classical logic. Are these driven by the way social speech might pose or frame elements of a mental model? I tried to answer some of these questions in the book with an examination of mathematical problem solving.

There is certainly executive control, which may or may not be social and in any case covers a variety of functions, as I outline in the book. What role does

self-directed speech and the form of language play in executive control? I have some potential answers below, but I want to underscore that the mere presence of executive control does not thereby elicit Vygotskyanism. That brand of socio-computationalism has, to me, quite specific questions and answers.

In my view, other sociocomputationalisms can proceed with no genuine use of Vygotsky (and, in my view, they have frequently used Vygotsky in perfunctory ways). To resonate with my proposals and be true sociocomputational alternatives, they must at least acknowledge the uniqueness and specificity of classical Vygotskyanism in order not to be simply one other variety of the proliferating theories of social mind. Unless there is such direct contact, using Vygotsky therein makes him look like everyone else who has made the claim that social facts bear on thought. How could that claim be anything other than true? He thus comes to look very much like Piaget, who I think is just wrong anyway in his cognitive theory (see below) and quite at odds with Vygotsky on some crucial points about social thought and language.

Vygotsky's experiments showed that children do not move from individual to social at the level of higher thought and as they become socialized and homogenized into all others, but instead use their social origins and social speech privately as a means to *individuate from a social group*. For Piaget, you become socialized as you learn the social structures all around you (a logical claim, it seems to me, but incorrect empirically); for Vygotsky, you are born social and have to learn to be an individual by using the social semiotic means around you. These are not the same view: Vygotskyan sociocomputationalism must provide mechanisms whereby social speech can be translated into the internal semiotic supports for individuals as they differentiate from the social group and engage in self-regulated behavior. Such a view requires a computable speech for thought. How does social speech go underground and drive metathought? Is there an internal landing site for the external through social speech, gone silent, as a guiding force? *Vygotsky and Cognitive Science* was all about these questions.

Exclusions and oversights

A number of commentators indicate that, by their reading, my brand of computationalism excludes or overlooks certain critical interactions of the social world and thinking, thus impoverishing my overall argument. This criticism surfaces in many places in the responses of Domingo, Rosa, Siguan, Lacasa, Gomila, and, to a certain extent, Silvestri. One such exclusion is culture. Some think that I have not appreciated culture in its fullest extent in proposing a computationalization of Vygotskyan socio-cultural mind. To this, my response is similar to that given to those who are concerned about my commitment to history.

We must be vigilant in differentiating culture from mere environment. Culture may be a tabulation of legitimate behavior and the evaluation of behavior, a kind of cosmological handbook for individuals who share a certain time and space. But unless the handbook is cognized, and unless it can be cognized in computational forms, culture has no bearing on thinking. Similarly, cultural des-

cription per se is a phenomenology, not a contribution to the explanation of thinking. For there to be a meaningful and useful relation between culture and thinking both in terms of the individual and context and the explanation of individual thinking in a cultural context, culture must have mental uptake. In short, culture requires cognitive science.

Furthermore, and more apposite to Vygotskyan cultural psycholinguistics, unless culture can be shown to be bound up with language, speech, and other semiotic resources with demonstrable cognitive influence, then accounts of cultural phenomena, no mater how interesting or potentially cognitive, remain outside classical Vygotskyanism. How do semiotic cultural supports get translated into speech for self-directed and other directed action in online thinking? That is a Vygotskyan question, which would differentiate Vygotskyan sociocultural psychology from mere cultural psychology.

It is well known that different cultures have different ways of organizing mathematical entities and of calculating, often combining mathematical ideas with other indigenous theories of divination, estimation, time, and social relationships. These cultures' mathematical systems can be shown to be entirely formal at base –universal and logical, transcultural– and computable; they reveal genuine mathematical perspicacity and insight in the minds of their users (see Ascher 2002). Moreover, it appears that the social context of mathematics and the use of public calculation allow these mathematical ideas to influence group and individual cognition, as in the case of public divination. Thus it appears that indigenous mathematics (is calculus an indigenous mathematics?) is used by minds with explicit semiotic support (e.g., props and special speech) in on-line problem solving as individuals and groups interact. Hence, the study of indigenous mathematics is a place for Vygotskyan socio-cultural computationalism. I do not examine such a process in my book, apart from looking at the role of speech in Western mathematical problem solving, but indeed such study of ethnomathematics is entirely appropriate for Vygotskyan theory under cognitive science. That is one way for culture to come into my proposals more than it may have.

A second area where there is some concern that I have excluded information is in language itself. My reading of these commentaries is that some think that I have overlooked the fact that language «really» is a pragmatic, communication system. Thus, linguistic analysis in the service of on-line thinking is principally an elaborated pragmatic analysis of such things as pronouns and other context markers. To a limited extent, I agree with this. There is no question that the pragmatic resources of a language are part of the way that speech for thinking comes about. But what I am proposing is something both more and less than sheer pragmatic analysis. If private speech is a marker of cognitive-computational control, then languages –*by their form*– give their speakers certain structures that foster and manage the interaction of the social and the cognitive-computational. These forms are not coterminous with the set of pragmatic markers, nor do they exclude semantics or syntax, or even semantically empty forms (since words, the workhorse of Vygotskyan linguistic mind, may have phonetic form but no meaning: see Jackendoff, 1997). Indeed, I think that there needs to be a new kind of socio-cognitive linguistic study that identifies, analyzes and ex-

plains the forms that individuals may marshal as cognitive control devices in on-line thinking. Such a study is neither pragmatics nor semantics.

Let me try to give an example. Carruthers (2002) has argued, correctly, I think, that language is the means by which mental modules talks to each other; language, in particular *logical form*, is the medium of cross-domain cognition and central processing because of its propositional explicitness. I believe that this is also one way to talk about inner speech. If Carruthers is right, then languages must differ in how they offer their speakers this cross-module, representational explicitness because they also differ in logical form: Chinese/English divergences in scope and logical markers are well known examples. How, then do differences in logical form –which is not semantic or pragmatic, but syntactic– translate into differences in the delivery of information across mental modules in on-line thought? This strikes me as a remarkably Vygotskyan research question, one that accepts (probably much to the horror of believers) Chomskyan linguistics as a correct theory of language. So, to me, much work needs to be done on the forms of language that can mediate culture and thought. I started some of this analysis in the book, but there is much more to do.

A third area where it is suggested I overlooked important interactions between culture and language is emotion. I agree that I did not say anything about emotions in *Vygotsky and Cognitive Science* –I knew so little about them then! In the interim, however, I have begun work on the cognitive-computational structure of emotions (Frawley and Smith, 2001).

Like history and social knowledge, emotions are contextual, individual, and subject to situational variation. Thus, they are excellent candidates for examination by varieties of cultural psychology. Whether *Vygotskyan* cultural psychology is the correct such variety is not clear. Do emotions play a role in the semiotic life of the mind and in the interaction of individual minds with the representational context? I think the answer to the first is *yes*, probably obviously so. Affective disorders, e.g., are typically diagnosed by an individual's failure to read and evince the public cues of emotions. Thus there seems to be something about emotions that perches them on the semiotic bridge between mental architecture and context and makes them good prospects for cultural psychology. But to get more Vygotskyan: do emotions rely on speech for thinking in same way that problem solving does, or, if Carruthers (2002) is right, as the way central inferencing does? I think the answer to these questions is: *we don't know, but it is unlikely*. Language and emotions obviously interact –you have to talk about what you feel, and emotions are almost certainly computable, especially in their «high road» form (LeDoux's 1996 term), where they affect cognition and metacognition. But whether emotions are also intrinsically linguistic in any way is unclear to me. Certainly languages represent emotions in different, culturally specific ways, but, as far as I know, speaking, does not seem to be essentially implicated in feeling. Indeed, the claim that emotions require speech is doubtful to me (unlike the self, which, to me, does need self-directed social speech and is obviously different from emotions since self and feeling can be neurally and cognitively dissociated). That is, you don't have to speak to feel in the same way that may have to speak to deploy higher thinking to solve problems and to know that you are a self.

So, I am in agreement with my commentators that emotions are social and cultural in some way, are the proper object of cultural psychology, and are indeed an essential part of sociocomputational mind. But are they linguistically or semiotically mediated? That needs to be answered in the affirmative before they can be brought into Vygotskyan sociocomputationalism, in my view.

Misreading the background

A final set of clarification lies in claims by commentators that I have misread the background material to my arguments, often in a critically incorrect way. Consequently, several commentators suggest that my arguments might be foundationally flawed, resting on a mistake: e.g., that I misperceive the unities in Wittgenstein and overlook his functionalism; that I cannot be a unification theorist and embrace Derrida; that I have bypassed all the correspondences between Vygotsky and Piaget. These claims, in one form or another, surfaces in the responses of Rosa, Lacasa, Domingo, Madruga. I wish to respond only very briefly to these objections.

First, let me turn to Wittgenstein. I believe that a careful reading of Wittgenstein shows many continuities between the earlier Wittgenstein and the later one. I have described those in *Vygotsky and Cognitive Science* (pp. 50-57 in the English version) with ample citation from the texts and critics. The glaring misperception of the later Wittgenstein that has permeated the literature and repeated erroneously is that he was a thoroughgoing functionalist, converting totally from a logician into a social meaning theorist and disavowing his wrongheaded past. Nothing could be further from the truth. The crucial passage in the *Investigations* reads: «For a large class of cases –though not for all– in which we employ the word 'meaning' it can be defined thus: the meaning of a word is its use in the language» (20, #43). As I have said, Wittgenstein advances a social theory, not of words, but of the meaning of *meaning*, and this theory neither dismisses nor is incompatible with ostension, nor does it cover every instance of meaning. It is this residual aspect of meaning that gives continuity between the early and late Wittgenstein. To read his crucial statement otherwise is to be irresponsible. There is truth other than functional truth, and that is one continuity across the two Wittgensteins. The same non-functional basis can be found in Vygotsky, who advocates three levels of thinking, with the highest as sociocultural and functional but built on a constant substrate. Neither thought nor meaning is social all the way down.

Second, let me remark on Piaget. Vygotsky and Piaget agreed on much –that is for sure. After all, Piaget is a logical theorist of development, not an empirical one –since empirical work shows much of what he said was wrong (Baillargeon, 1995, e.g.). So, if Piaget was at all right on anything, they had to agree on some things about the necessities of development. What could be more self-evident than the fact that children become socialized, they learn conjunctions before causes, they have to be cognitively ready to acquire certain speech forms, their biological maturation affects their cognitive structures, and they have to learn abstract operations as they unlearn concrete perceptual ones? To me, a lot is wrong with this. For

one thing, some of this «logic» is just wrong: children's language runs a path independent of their cognition (they speak about abstract complex causes well before they ever pass Piagetian tests of causal cognition: Pinker, 1994) and many have shown that the cognitive operations of Piaget's stages of development are present at birth and do not mature from exposure (again see the work of Baillargeon). For another, Vygotsky and Piaget disagreed strongly on the role of language and social context in mental development. As I have said in many places, when it comes to higher thought (metaconsciousness), Vygotsky believed that children are born social and have to learn to be individuals through the use of self-directed social speech that has been truncated into speech for thinking. *This is the opposite of what Piaget claimed.* The crucial test lies in egocentric speech, which, Vygotsky observed, is never lost, but surfaces as a support for higher thought in individuals in difficult situations and develops as an individual means of thinking when speech and thinking intertwine. Thus, children's higher thought via speech is initially individual only in social contexts (when they speak to themselves in the presence of others) and then becomes social in individual contexts (when they speak to themselves in social speech when they are alone). This is not Piaget's theory at all.

Have I misread Piaget, not used him enough? Why is there not more Piaget in *Vygotsky and Cognitive Science*? It is because Piaget is wrong in fundamental ways about what thinking is and how it develops, and he is certainly not at all in agreement with Vygotsky on what I take to be the core of classical Vygotskyanism –the role of speech in embodying and executing relevant social context in the development of higher thought.

Finally, there is Derrida. A number of commentators, Madruga in particular, observe the paradox in promoting a unified theory of mind that uses deconstruction, which gets its power from the absence of synthesis. I agree with this criticism, and acknowledge that I probably suggested too strongly that using Derrida to interrogate Wittgenstein led to a coherent theory of mind. I think, however, that there is a difference between an integrated theory of mind, where differences are lost (contra deconstruction), and a unified theory of mind, where differences are maintained in productive tension. I was hoping to promote the latter. I see Wittgenstein as I see mind: a constellation of discrete modules, not a synthesis. I think both Wittgenstein #1 and Wittgenstein #2 existed in productive tension in a single Wittgenstein; likewise, both socio-functional mind and deterministic mental computation exist in productive difference: in a unity, but not an integration. The failure on my part was not to push Vygotsky's Marxism enough to allow Hegelian synthesis vs. the Derridean play of opposites. I do not yet know how to work this out, and think it may not be possible. But I do not think this shortfall undermines the argument fatally. In the end, my commitment to unity of competing opposites over integration is why I advocated a step back from a grand scheme theory of mind at the end of the book.

Aspects of a Future Vygotskyan Cognitive Science

Now that I have tried to respond to my critics and commentators, I want to briefly sketch out some directions for a future Vygotskyan cognitive science,

built at I think it must be on sociocomputationalism. The first area of promise is working memory. In my reading of the views of Carruthers (2002), summarized in Frawley (2002c), Carruthers argues that two formal aspects of language –Logical Form (LF) and Phonetic Form (PF)– are the means by which representations from non-linguistic modules are made explicit so as to serve cross-domain mental processing and inference (see also Frawley, 2002a, 2002b). Hence, these forms of speech serve on-line thinking, and we might thus see Vygotsky's essential claim about speech for thinking as a claim about the form of language in working memory. It is well known that acoustic and articulatory codes are activated in working memory, and if we can also see inner speech as something like the deployment of phonetic form as the means of inter-modular processing, then we ought to get specific effects of speech on the disruption of non-linguistic tasks in working memory. That is, inner speech ought to be disruptable in non-linguistic on-line tasks. Baddeley's (1999, pp. 50-51) observation that recall of visually presented numbers can be disrupted by linguistic input is perhaps evidence for this cognitivizing of the classical Vygotskyan position. Moreover, as Baddeley (1999) observes, when individuals suppress speech, they have problems transferring visual material to short-term phonological store, which implicates the involvement of speech in domain-crossing. I would hope that detailed experimental work on this subject would reveal more about the role of phonetic and logical form, and their integration in a Vygotskyan theory of computational working memory.

A second area of promise is a renewed examination of linguistic relativity. Logical and phonetic forms, even in formal theories, have known patterns of variation. If these aspects of language are the way that speech is translated into a vehicle for higher thought in working memory, then variation in the form would result in variations in the instruments of on-line thinking. Is this another, sociocomputational way of talking about linguistic relativity? Do languages differ in the way their formal structures provide the working memories of their speakers alternate formats for silent predication (LF) and informational ordering (PF)? Baddeley (1999, p. 53) observes that the articulatory loop in working memory is an effective monitor for informational order of information, and measures of working memory have been claimed to be a more accurate measure of individual variation and performance than IQ. Does a renewed sociocomputational Vygotskyanism also renew linguistic relativity as a claim about how languages offer their users alternate means for silent and self-directed linguistic explicitness as they think in real time?

A third area of promise has to do with evolutionary psychology. Much has been said recently about the resurgence and relevance of evolutionary theories of cognition (Pinker, 1997, 2002). It seems to me that sociocomputationalism and Vygotskyan cognitive science have a significant role to play in the latest evolutionary explanations of the human mind. Current theories of human development trace the emergence of cognition to the brain structures that support and check social relations, tie speech to exapted motor programs, and identify expanded neural development for cross-module information flow and executive monitoring (Deacon, 1997; Dunbar, 1996; de Waal, 2002; Sober and Wilson, 1999). I

see Vygotsky as a natural partner in all this theorizing. Could it be that one thing that makes us human is that we have evolved speech into thinking? Could it be that humans have evolved an elaborate working memory buffer (Bownds, 1999) that is sustained and in some sense constituted by social speech reduced to silent predication which, by its form, serves cross-domain thinking because it is a good way to make information explicit and so serve higher thought as it monitors real time thinking?

I find these questions intriguing because, if the answers to them are *yes*, then it means that Vygotsky is the future of cognitive science and computationalism (not the other way around, as some of my commentators insist). A fully informed evolutionary psychology –i.e., a theory of what makes humans human– must appreciate classical Vygotskyanism as translated into cognitive science. That is why I am still a sociocomputationalist, and why I think you should be, too.

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Significado e implicaciones de una teoría: a vueltas con la modularidad de la mente

Tal como decíamos en la presentación general de este volumen, la discusión de las ideas de J. Fodor de la constitución modular de la mente se ha avivado en los últimos años. No hay duda de que la teoría ha tenido un impacto formidable y duradero en el ámbito de la psicología cognitiva, y sigue teniéndolo. Ha logrado además la difícil virtud de funcionar como referente teórico en dos niveles muy distintos y nada fáciles de conjugar –y, por ello, poco comunes: el máximamente general que representa el formular una teoría de la arquitectura *mental o del fondo estructural y fundamental del sistema y funcionamiento cognitivo, y, a la vez, el constituir una fuente de hipótesis mucho más específicas para la prospección e interpretación de datos empíricos en áreas de investigación precisas y restringidas. Ahora bien, precisamente por ocupar simultáneamente un lugar a la vez central y múltiplemente local en el panorama de la investigación cognitiva, ha ido teniendo que lidiar con múltiples y poderosos antagonistas teóricos. En los comentarios que a continuación se ofrecen se hace patente esto que decimos. Los frentes de discusión son muchos, la posibilidad de síntesis final... o muy complicada en estos momentos o sencillamente prematura. Pero si las teorías valen por su capacidad de promover investigación y discusión, la de la modularidad constituye un valor seguro. Y su discusión proporciona un cierto retrato de muchas de las preocupaciones e incertidumbres que la investigación cognitiva viene deparando.*

Palabras clave: J. Fodor, mente modular, modularidad masiva, innatismo.

As we mentioned in the introduction to this volume, the debate surrounding Fodor's ideas on the modular constitution of mind has experienced a revival in recent years. The impact of Fodor's theory in the ambit of cognitive psychology is still felt today. Furthermore, it has managed to serve as a theoretical reference point at two very different, almost incompatible levels: at the highly general level, aiding the formulation of a theory of the mental architecture or the structural and fundamental background of the system and cognitive functioning; and at a more detailed level, constituting a source for much more specific hypotheses for the exploration and interpretation of empirical data in specific, circumscribed research fields. However, precisely because it holds both a central position and a multitude of more specific ones in the field of cognitive research, it has had to face numerous and powerful theoretical challenges, as the following comments reflect. The areas for discussion are many, the possibility of an eventual synthesis too complicated or simply premature. But if the value of a theory lies in its capacity for promoting research and discussion, then the position of the modularity theory seems assured. Its discussion sheds light on many of the concerns and uncertainties present in the field of cognitive research.

Key words: J. Fodor, modular mind, massive modularity, innatism.

Fodor y la modularidad de la mente (veinte años después)

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En el amplio panorama bibliográfico de las ciencias cognitivas, es difícil encontrar una obra que haya sido más citada, comentada y discutida que el libro *The Modularity of Mind* (en adelante, MM), publicado por Jerry Fodor en 1983 (con traducción española de 1986). Detenerse a examinar el impacto de MM en estos veinte años conduce, de forma casi inevitable, a hacer un balance de lo que ha sido la propia investigación cognitiva durante este último periodo. Dicha tarea, realizada con la extensión y el rigor apropiados, desbordaría con mucho los límites sugeridos para este comentario. Me conformaré, por ello, con atender a un par de aspectos que me parecen importantes. En primer lugar, me interesa destacar el lugar que ha ocupado MM en la obra de Fodor, y cómo se conecta la idea de modularidad con otras facetas de la visión fodoriana de la mente cognitiva. En segundo lugar, y mirando más hacia el futuro, trataré de mostrar hasta qué punto se puede seguir considerando MM como un programa abierto de investigación y cuáles son algunas de las principales cuestiones pendientes de solución.

Una mirada hacia el pasado: la modularidad en contexto

Cuando se publicó MM hace veinte años, hacía veinte años que Jerry Fodor se había incorporado al MIT y, atraído por el trabajo de Noam Chomsky, participaba de forma destacada en el cambio paradigmático que se estaba produciendo más o menos simultáneamente en la lingüística, la psicología y la filosofía de la mente. La convergencia de intereses de estas disciplinas, junto con las aportaciones de las ciencias de la computación y de la neurociencia, contribuirían a configurar el ámbito interdisciplinar de la ciencia cognitiva. En este clima innovador, Fodor desarrolla una amplia labor en varios frentes: la reflexión filosófica sobre el nivel propio de la explicación psicológica ante los intentos reduccionistas; la reivindicación de la psicología del sentido común y las actitudes proposicionales; sus primeras aproximaciones al problema del significado, en el contexto de las relaciones entre pensamiento y lenguaje; la fundamentación y desarrollo de la hipótesis del lenguaje del pensamiento (mentalés), pieza clave de la teoría representacional/computacional (R/C) de la mente; y, ya en el campo de la investigación empírica, la puesta en marcha de un amplio programa de psicolingüística experimental, referencia obligada para entender los desarrollos posteriores de este campo de estudio en el marco de la psicología cognitiva y la lingüística generativa.

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