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Building interfaces between the humanities and cognitive sciences

The case of human speech

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ABSTRACT

I argue that creating *interfaces* between the humanities and cognitive sciences would be intellectually stimulating for both groups. More specifically for the humanities: they might gain challenging and rewarding avenues of inquiry, attract more funding, and advance their position in the 21st-century universities and among the general public, if they engage in interface projects with cognitive science and other disciplines that seek to improve our understanding of what it means to be human. I discuss a potential research framework of non-linear dynamics for such interfaces, and argue that it alleviates some of the concerns of reductionism and determinism that scholars in the humanities might have in relation to the scientific approach. I also discuss some general examples from the study of human speech of how successful interfaces have been built and might be extended to other areas relevant to the humanities.

KEYWORDS *cognitive sciences, interface, mind–body, non-linear dynamics, speech, turn-taking*

INTRODUCTION

THE ROLE OF the humanities in the modern university has recently come under intense scrutiny.[1] Debates concerning the feasibility and fruitfulness of the long-standing divide between the humanities and the sciences have opened the call for external justification of the humanities. The theorizing about aspects of ontology, epistemology or methodology, fueled by disproportionate voices of the extreme views from both sides, gives the impression of seemingly

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irreconcilable differences and of no meaningful way of bridging the divide. Slingerland (2008) characterizes places of higher education as BIversities rather than UNIversities, reflecting the current deep divide between the sciences and the humanities. Some scholars within the humanities believe that scientific study cannot help, and even blocks, true understanding of what makes us human.[2]

However, this black-and-white view of the sciences–humanities relationship is certainly simplistic. Firstly, Hart (2001) aptly argues that the space between realist and relativist epistemologies, the former typically associated with the sciences and the latter with the humanities, is in fact a continuum. She describes how a position on the continuum necessarily subsumes weak or constrained constructivism by accepting that the mind as a medium filtering all human knowledge is the product of contextual influences but that, at the same time, the mind is embodied and thus dependent on or constrained by biological and evolutionary forces. Hart then discusses the epistemologies of cognitive and cognitive-evolutionary positions in the current research of literary criticism along this continuum. The first position is closer to the relativist tradition but accepts cognitive views such as Theory of Mind while the latter is closer to the realist tradition and sees evolution as a causal principle in the interpretation of literary works.[3]

Secondly, the field of intellectual inquiry includes disciplines such as psychology, sociology or anthropology that combine methodologies and approaches from both the sciences and the humanities. Even literary criticism, typically considered close to the relativist end of the continuum, relies inevitably on empirical data provided by the book's and the author's historical contexts, and may benefit from empirical and quantitative analyses of stylistic and other artistic devices in the texts.

Thirdly, Slingerland (2008) nicely describes how the extreme, unyielding realist and relativist views feed each other and serve to justify each other's extreme positions. Slingerland's view is that human cognitive nature probably operates with less extreme, more 'folk' versions of both positions. Additionally, although Gould has argued against the integration of the humanities and the sciences, his characterization of the unhealthy divide echoes Slingerland's view:

> The greatest sadness of this situation lies in the irony that no such opposition [between the humanities and sciences] exists, either in abstract logic or in genuine practice. Rather, our false categories and bad mental habits have constructed a phony war and then actually managed to impose its apparatus upon our social and intellectual landscape. (Gould, 1998: 87)

Finally, there are on-going efforts at bridging the humanities–sciences divide in higher education. Several successful interdisciplinary programs are already

running at undergraduate and graduate levels.[4] These programs not only work for the benefit of the students but also bring scientists and humanists to the same table. These conversations are not easy and it would be naïve to expect that just bringing the two parties to talk to each other will magically resolve deep epistemological divisions. For example, Davis notes the persistent lack of compromise on data interpretation in his bio-culture program between the scientists who see data as 'hard facts' and humanists who stress that social, cultural and political forces affect the data. Nevertheless, the channel for exchanging ideas provided by such interdisciplinary programs is extremely important.

Given the complex picture of the relationship between the humanities and the sciences, my aim is similar to that of Wilson (1998) and Slingerland (2008), that is, to inspire and galvanize interdisciplinary cooperation between humanists and (cognitive) scientists. The work of Wilson, especially, has received a lot of attention but has drawn largely negative responses from the humanities.[5] Wilson is often criticized for being a too radical reductionist and suggesting that the epistemological issues of human nature, including traditionally humanistic areas of ethics, theology, aesthetics, etc., cannot be fully grasped if they are not reduced to deeper or more fundamental layers of evolutionary genetics and biology. His critics argue that the 'whole is not the sum of its parts', and hence 'hard' reductionism is not appropriate for the humanities. On this issue, my view is different from Wilson's and I do not think that the humanities could or should be reduced to sciences. But I disagree with claims that the epistemologies of sciences and humanities are completely separate (Gould, 1998). In fact, we can learn a lot from investigating the human condition through the relations between the layers of the multigranular complex system in which humanity resides. I also disagree with the idea that consilience between humanities and science necessarily means blurring of the disciplinary boundaries, which is not needed for the humanities (Rorty, 1998). Hence, my suggestion for bridging the divide involves a different view of the reductionism issue, and offers a potential 'non-blurring' methodological path for such interdisciplinary research, which allows ample room for reconciliation between the two cultures.

I would like to argue here that the humanities should not *integrate* with the sciences but should rather seriously consider creating *interfaces* with them. I construe *interface* as a space creating intersections of two or more disciplines by negotiating issues of methodology and (linguistic) description among those disciplines. In other words, an interface is a platform for exchanging ideas in the fields traditionally divided by strong non-porous boundaries. Initially, no changes in the epistemologies and the objects of the study within the disciplines should take place. This is because an interface is a 'neutral' concept in

the sense that none of the disciplines assumes primacy over the other, and certainly none of them should feel a threat of colonization. After all, it is not clear where the relationship between the disciplines will go once they are able to talk to each other. Most likely, some additions or modifications in both disciplines will have to take place so that an epistemological rapport between scientific and humanistic approaches can be reached. Such an interface space would also create a forum for scholars from both sides to comment on the methodological and descriptive issues in a constructive way, so that legitimate concerns may be addressed and scholars attempting to run interface projects don't feel threatened from both sides.

In this light, I see it as one of the goals of the humanities in the 21st century to make themselves more available for interdisciplinary projects with cognitive science and other disciplines that seek to improve our understanding of what it means to be human. I would argue that the enterprise of interface creation does not necessitate big sacrifices in the core assumptions of humanities, but it does require some openness to changes, mostly in approaches to data. Such projects are intellectually stimulating and have potential to bring funding and attract students, both graduate and undergraduate. I will try to show how humanists can both add to and profit from such interfaces. Before I discuss these issues in more detail, allow me a short excursus to the field of my expertise – the study of human speech – that serves as the first example of the potential of such an interface between 'scientific' approaches and those that share characteristics with the humanities.

DUALITY IN THE STUDY OF HUMAN SPEECH

Human speech is one of the great windows for understanding how the human mind works. Traditionally, a dual approach to the study of human speech was preferred. *Phonology* studied discrete aspects of our linguistic competence that are thought to be not directly observable. Phonologists model this competence using logical operations over abstract symbolic representations. So for example, in German, people pronounce [d] in *Rades* ('wheel-Genitive') but [t] in *Rad* ('wheel-Nominative'). Phonologists model this alternation as a process called voicing neutralization, in which all voiced obstruent sounds change to voiceless if they occur in word-final position.[6] Crucially, [d] and [t] have been traditionally assumed to be abstract symbolic mental representations not connected with their actual realizations in the mouth.

Phonetics, on the other hand, deals with the continuous manifestation of this competence through the study of directly observable articulatory actions and their acoustic consequences. So it is possible to quantify the difference

between [d] and [t] for any realization of these sounds. The division between phonetics and phonology, and the findings of phonology in particular, significantly advanced our understanding of human cognitive abilities and also led to important results in formal language theory, which are widely applied in computer science (for example in designing programming languages or discrete algorithms) or in designing speech synthesis applications.

However, the division between phonetics and phonology also resulted in the development of different methodologies, different views on what represents data, and a general difficulty of forming theories capturing both the 'mind' and the 'body' aspects of speech. Moreover, one of the core assumptions underlying the traditional dual approach – the idea of derivational precedence – has been challenged by recent findings. This is the idea that first the cognitive system representing speech performs discrete phonological computations, such as the change from [d] to [t], and then there is a transducer mechanism that transforms the results of such computations into the continuous articulatory movements. For example, returning to our example in German, it was shown that the [d] → [t] change is not categorical, but that there are degrees of how much devoicing takes place; moreover, the amount of devoicing depends on external factors such as the intent to communicate the contrast between the sounds (Gafos, 2006). Note how 'intention' moves the research questions ever closer to the humanities. These findings are difficult to reconcile with the model where phonology is a closed system separated from phonetics, and information flows only from the former to the latter.

Hence, the traditional dualism between phonetics and phonology is a quintessential mind–body problem and as such bears on the divide between the humanities and the sciences. Phonology has developed as a science with theories for its fundamental units and operations on them that are predictive and in principle falsifiable. However, it also shared with the humanities the rejection of embodiment and grounding of these models in 'bodily' phonetics. Additionally, the presumed Chomskyan boundary between competence and performance made it impossible to study phonology as embedded in the social environments through traditionally humanistic concepts such as discourse, power or culture. Hence the presumed self-containment of phonology in relation both to the 'lower' level of description in phonetics as well as to the 'higher' level in society and culture provided several correlations to the humanities–sciences dualism.

Laboratory phonology (LP) is an approach that builds interfaces between lower and higher levels of descriptions relating to human speech. Several issues in this enterprise are pertinent to the humanities–sciences interface approach that I wish to advocate. LP has evolved into a coalition of researchers from a conference with this name organized in 1987 (Pierrehumbert et al., 2000).

LP rejects dualism in the study of speech and strives to improve our understanding of the relation between the discreteness of phonological knowledge and the continuity of phonetic substance. Moreover, social conventions, as they relate to language, are viewed as a natural phenomenon that is not arbitrary but complex. Laboratory phonologists approach this complexity similarly to the way the complexity in other natural phenomena, such as the weather, is approached. There are several characteristics of the LP approach that are relevant for the idea of interfaces between the sciences and the humanities.

Firstly, the LP approach uses methods and techniques shared with other sciences, benefiting from advances in instrumentation, statistical analysis and mathematical modeling. Some humanists might argue that this empiricism moves LP further away from direct observation by inserting instruments and methods that are heavily theoretically biased and are in fact the creation of humans after all. Any information obtained with such instruments might be perceived as even more relative than what is obtained without them. However, when such instruments are applied rigorously, and especially if the results are subjected to rigorous statistical analysis, the observations gathered are less subjective than would have been otherwise the case. A thermometer gives a more objective reading of a patient's temperature than touching her forehead with the palm. That does not mean that the first observation is better than the second, but the first allows for building and testing of formal models better than the second. A very exciting and productive area of inquiry in cognitive science has been to study the relationships between the two types of observations, thus learning a great deal about human cognitive processes.

Secondly, the LP community makes every effort to maintain a well-defined common vocabulary that can be used by opposing parties in an argument, in evaluating theoretical proposals, and also in communicating the results to other fields and to the general public. This is possible because the LP community actively strives not to use any particular theory or framework, and attempts to ground as many of its concepts as possible in levels of inquiry that are different and to some extent independent from the level of LP inquiry.

Thirdly, adherence to the general LP approach creates potential for interface disciplines such as neuro-linguistics or speech recognition that have enormous applicability in everyday life. This is possible because, crucially, LP acknowledges that both high- and low-dimensional aspects of speech need to be described. Thus, in the quest for improving our understanding of the human mind through speech, phonologists, and linguists in general, find themselves collaborating with neuro-biologists, psychologists, computational scientists and others. This brings new potential for linguistics, as a traditional part of humanities, to participate in publicly funded projects and educate the general public about the use and justification of humanities.

Lastly, the LP research agenda also relates to teaching in higher education because it emphasizes analytical reasoning, data collection and analysis, building up theories and their testing against new data, and using all this methodology for a better understanding of the human mind. If such a course is cross-listed with the courses exploring language in the traditionally humanistic approaches, both tracks will benefit.

To summarize, several concepts from the successful interface-building approach of laboratory phonology could be incorporated into the interface between the humanities and cognitive sciences. Specifically, there is a need for a theory-independent but independently grounded vocabulary for describing the results of research and methods that can provide a means of deciding which of the hypotheses, analyses and interpretations are closer to truth.

EMBODIMENT, EMERGENT PROPERTIES AND NON-LINEAR DYNAMICS

It seems that reductionism and determinism, assumed to be required in the scientific approach, represent an important, and partly justified, concern for scholars in the humanities. Although some humanists would argue that reductionism and determinism are not primary obstacles for the humanities–sciences interface, worries that natural scientists' wish to reduce human-level concepts such as beauty or freedom into lower-level processes determined by physical or biological descriptions are at the back of many humanists' minds (Slingerland, 2008). Ceccarelli (2001), in her insightful analysis of the generally skeptical and negative reviews of Wilson's (1998) controversial book, names hard, or in Dennett's terms greedy, reductionism as one of the primary problems. Furthermore, even those humanists who position themselves away from strong relativism and acknowledge the usefulness of cognitive science in the humanistic studies may find it difficult to come to terms with reductionism. For example, Hart (2001) says that the cognitive evolutionary approach to literary criticism is less likely to succeed than a cognitive non-evolutionary one, and says that the cognitive evolutionary approach cannot help but inspire charges of reductionism. She then identifies those reductionist worries as the causal primacy of genes, or the notion that culture can be reduced to an effect of biology.

Of course, the worry of reductionism reflects an epistemological duality, the difference between describing and explaining what 'is' and discussing what 'could or ought to be'. But I believe that the sciences and humanities are both interested in 'what is and how it changes' in the domain of human nature. In this section, I would like to suggest that recent advances in the application of

non-linear dynamics to human cognition and behavior (Kelso, 1995) might alleviate some of the concerns about reductionism and determinism by seeing higher-level humanistic concepts as emergent properties of a complex embodied system of human cognition. An 'emergent' property observable at one level is the result of *non-linear* relationship(s) among properties of different levels of observation, and thus cannot, in principle, be fully reduced to the workings of these subsystems only. Hence, beside laboratory phonology, non-linear dynamics is yet another line of research attempting to approach different levels of description within a unified single system, maintaining if necessary epistemological differences between them, and providing formal and methodological tools for describing these levels.

Research in cognitive science suggests that 'consciousness is not a mysterious substance distinct from matter but rather an emergent property of matter put together in a sufficiently complicated way' (Slingerland, 2008: 10). The core idea in my proposal is that consciousness is a complex system of many levels of different granularity, and that studying those levels separately and according to different methodologies and assumptions is less fruitful than studying them as one system. Non-linear dynamics is a formal approach supported by empirical results that allows approaching higher-level concepts like consciousness within a single unified system together with lower-level concepts.

Let me illustrate this concept with a simple example from limb coordination (Kelso, 1995). Kelso asked his subjects to oscillate both index fingers with the frequency of each finger following a metronome with increasing frequency. He noted that there are two stable modes for this task: the in-phase pattern is when the same muscles contract at the same time and fingers move toward and away from each other, and the anti-phase pattern when both fingers move in the same direction. If subjects are instructed to start with the anti-phase pattern, and the frequency of metronome beats gradually increases, they spontaneously shift to the in-phase pattern. If, however, they start with the in-phase pattern, no such switch occurs. Hence for some frequencies of oscillation there are two stable modes, but at some critical value the behavior of the system changes and only a single stable pattern is possible. Frequency of oscillation is thus a lower-level control parameter and the in-phase and anti-phase behavior represents stable higher-level patterns.

Kelso nicely shows that this simple concept of coordination characterized by the stability of the higher-level patterns over some intervals of the control parameters and extreme instability over some other intervals could be extended to domains such as intentionality, learning, and ultimately to the processes of self-organization in the brain. For example, experimental results show that intention can be modeled as a parameter that improves the relative

instability of the anti-phase pattern and affects the switching between the two stable states. In speech, Gafos (2006) showed how the experimental results from voicing neutralization in German, where the degree of [d] → [t] change in words like *Rad* is affected by the intention to improve the discrimination between words like *Rad* and *Rat*, can be comprehensively modeled with non-linear dynamics, and, crucially, cannot be modeled assuming a hard mind–body boundary.

When researchers in humanities try to add to the understanding of what it means to be human, they are inevitably involved in looking for patterns (in character development, perception of art in the population, etc.).[7] Pattern identification is a fundamental feature of our lives, and pattern formation has been the object of inquiry in sciences for a long time, for example in biology, ecology and other disciplines studying complex behavior. Interaction between various forces is the basic underlying principle of nature, and is studied also in chemistry or physics. The formal language capable of describing pattern formation in real time through interaction of various parameters is dynamics. Hence, non-linear dynamics offers a tool for studying many phenomena observed in nature and society such as locomotion, audio and visual perception, relationships between predator and prey or between supply and demand, eddies and vortexes in a stream, or relations between crime level and cleanliness in New York City's subways.[8] As pointed out by Gelder and Port, 'dynamics . . . happens to be the single most widely used, most powerful, most successful, most thoroughly developed and understood descriptive framework in all of natural science' (Gelder and Port, 1995: 4). So why not consider what non-linear dynamics might offer the humanities?

There are several advantages to approaching questions in the humanities dynamically. Firstly, the abstract nature of dynamic formalism has the potential for varied applications, which may provide a vehicle for the bridging of thinking and methodologies across a broad range of disciplines.

Secondly, dynamics provides us with explicit mathematical tools applicable to the issues confronted in humanities. For example, the notion of the stability of a system is well understood, and many successful models in economy, ecology, physics or cognition are based on the mathematical expression of dynamic stability. Although the culture studied by the humanities is constantly changing, the existence of some stable patterns is the very condition that allows us to study it. Dynamics provides us with mathematical tools to account for this stability as well as with the formal language capable of handling changes in lower-level parameters and their effect in strengthening or disrupting this stability at higher level(s).

Thirdly, a dynamic model can be generally characterized as quantitative or qualitative. A quantitative model captures the observed phenomenon by

setting out correspondences between the numerical data produced by the model and those observed experimentally. A qualitative model improves our understanding of a particular phenomenon by providing a mathematically well-defined framework that exhibits the behavior that is qualitatively similar to that observed in the experimental data. Exact fitting of the observed data to the numerical output of the model is not crucial in a qualitative model. This feature of the model is especially useful for our discussion since it emphasizes the need for both qualitative and quantitative descriptions. Hence, in a hypothetical interface project that brings together humanists and cognitive scientists, non-linear dynamics provides a platform for fruitful exchanges of observations and great potential for intellectual advancement in both groups.

Fourthly, dynamics provides a specific paradigm for approaching the mind–body problem and easing the worry about reductionism and determinism that humanists might have. There are various higher-level patterns observable in the data typically analyzed in the humanities but these patterns are necessarily embodied: they (did/should) occur in the real world and bodies. Hence, to effectively study the higher-level patterns, we don't have to reduce them to lower-level parameters, since the two co-evolve influencing each other. By the same token, both lower- and higher-level parameters are needed if we are to account for the observations; it is not the case that either of them can determine the output on its own. Kelso's thought on reductionism is worth mentioning here: 'The very idea that the brain follows principles of self-organization in which global states might be characterized in terms of collective variables that follow a dynamic capable of creating enormous human behavioral complexity seems anathema to the materialistic reductionist' (Kelso, 1995: 28). In other words, non-linear dynamics allows for both bottom-up and top-down processes to be seen within a single vertical unified system, which can increase the explanatory power of any horizontal approach.

The openness and self-organization of non-linear dynamic systems discussed in Kelso (1995) are crucial concepts for our discussion of interfaces. Since language, culture and our perception of the world are constantly changing, any proposal for covering these phenomena has to be open in the sense of allowing the influence of various constraints and parameters that are able to shift the system from one stable mode to another. The self-organizing nature of these dynamic systems allows us to avoid the ghost-in-the-machine problem. As Kelso suggests, 'thought emerges as a collective, self-organized property of the nervous system coupled, as it is, to the environment. . . . coupling might be quite independent of the physical medium through which they are realized. They are, strictly speaking, informational couplings' (Kelso, 1995: 288).

And finally, dynamics allows us to maintain a 'weak' version of dualism as a working hypothesis. By 'weak' dualism I mean that some first-person observations, such as our internal first-person intuitions, may be different from the third-person observations that can be made about them; that there is something uniquely human that does not correspond in any way to descriptions on other levels. Or, as Feldman (2006) points out, despite the rising body of evidence for the embodiment of higher-level processes, we have to maintain the possibility that our personal and subjective experiences, sometimes called phenomenological or qualia, are not describable by science, or, that the scientific explanation exists but humans can never find it. However, humanities–sciences interfaces based on dynamics offer a framework within which improved understanding at one level may drive important advances at the other: thus, hopefully, learning more about ourselves.

Similarly, cherished humanistic concepts such as fine texture, nuanced expression or multilayer structure do not have to be sacrificed under weak dualism, although interface research might provide new handles for approaching them.

ADDITIONAL ARGUMENTS FOR INTERFACES

Additional support for interfaces between humanities and (cognitive) sciences comes from the area of embodied cognition. For example, Johnson (2007) argues that notions such as emotions, quality and feeling are not merely subjective aesthetic judgments and tastes, but rather are part of human capacity to make and experience meaning, and arise from embodied cognitive processes. Johnson then argues that aesthetics has been traditionally linked to arts since arts exemplify 'consummated meanings', but the need is 'to explore how meaning is possible for creatures with our types of bodies, environments, and cultural institutions and practices' (Johnson, 2007: xi). Similarly, Gallese and Lakoff (2005) review the research on understanding pointing out that we can reason about some sensori-motor activity without the sensori-motor input but we use the same brain circuitry for that. They argue that understanding involves imagining and, since the brain circuitry is definitely used for imagining, understanding must be embodied as well.

The espousal of embodied cognition lets us escape extreme forms of relativism and skepticism by including us humans in the physical world. Although we might not be able to observe the world out there directly, the intermediate structures that shape our perception of the world, like language or vision, are the products of ourselves (our brains) as well as the evolution/adaptation to the world. Moreover, as Clark (2008) observes, we also need to think about

including 'external' objects into our model of cognition such as white-boards, pen/paper, or computers, which is impossible without thinking of the mind as an interconnected system of lines criss-crossing the boundaries of the brain, body and world.

Research into the facial expression of emotions points to the idea that both our physiology and our culture cocreate our emotional world. It has long been known that basic emotions such as fear, happiness or anger are universal irrespective of culture. Matsumoto and Willingham (2009), working with natural data on facial expressions during competitions, showed that people of all cultures possess the same facial expressions of emotion, which, in turn, are the same as those of congenitally blind people. Hence, these expressions are bodily in nature, have been traced to the subcortical area of our brains, and are not affected by our culture. However, we are also able to produce and perceive facial expressions driven by our cultures, and these have been traced to a different cortical area in our brains. Typically, the innate expression is first, it is extremely brief and then the cultural expression is overlaid on the innate one. Therefore, our facial expressions of emotions are neither universal nor cultural; they dynamically influence each other.

Other examples include the effect of bodily movements on value judgments and the importance of embedded social and cultural constructs. Wells and Petty (1980) showed that vertical head movements (nods) facilitate positive value judgments while horizontal ones (shakes) yield more negative ones. Gigerenzer (2007) described how models of human decision making based on mathematics and statistics are outperformed by cognitive higher-level heuristics approaches influenced by social and cultural motives. Crucially, these heuristics are inevitably embodied; see also work by Damasio (1994) on somatic markers.

Further to alleviate the worries about reductionism that scholars in humanities might have, another example from biology is revealing. In connection with efforts at human genome reconstruction, the ideas of embodiment and of evolutionary perspectives in humanities were met with worries that all human nature would be reduced to the workings of the genes. But the outputs of long nature–nurture debates show that the two systems (genes and environments) are mutually complementary, they influence each other just as phonetics and phonology do and just as the mind and body do. For example, in the 1990s there was huge promise for the research on genetic predispositions for special language impairment (SLI) or autism. The changes in gene FoxP2 were identified as correlating with various language-related problems. However, subsequent rigorous testing of this hypothesis showed that human language faculty is very 'resilient' and probably due to brain plasticity and complex interactions among the genes themselves and their interaction with

environment: a single functional genetic difference typically does not produce symptoms of impairment (Bishop, 2009). Hence, SLI cannot simply be reduced to gene specification. Yet, in the inquiry, we have learned a great deal about the relationship between higher-level language processes, this time seen through language impairments, and lower-level genes. For philosophical arguments for how genes can only provide crude long-term and probabilistic instructions that inevitably coexist with the environmental and behavioral challenges see Dennett (1995).

The lesson to learn from the genes is that even failed attempts at reduction may open new possibilities and avenues for research. I believe that the humanities are in a similar win–win situation with potential interface projects. Either we find that some questions in the humanities (or their parts) could be meaningfully approached through embodied or otherwise interface projects, or such an approach would not ultimately fulfill these expectations but would certainly bring new questions and approaches – the 'steam' that Latour (2004) argues the humanities have lost.

HOW COULD HUMANISTS ADD TO AND BENEFIT FROM INTERFACE PROJECTS WITH COGNITIVE SCIENCE?

Firstly, humanists are indispensable in formulating challenging questions. It is common for sciences to pose questions that are possible to investigate within the given and established theoretical, epistemological and methodological paradigms. But this approach is rather restrictive and almost certainly misses broader and more complex issues concerning the roles of discourse in those questions. Moreover, humanists provide useful reminders that the way research questions are framed has serious implications for the whole research; there is thus a need for the appreciation by scientists of how cultural and other influences bear on these issues. This should prompt scientists to improvements in their experimental designs as well as in data interpretation.

Taking another example from the history of linguistics, new neuro-imaging techniques and advances in neuro-science would not be able to give rise to neuro-linguistics if there were no groundwork done on understanding and modeling linguistic structures. This understanding enabled the asking of empirical questions using the newly available neuro-imaging techniques. Hence, any empirical approach would greatly benefit from the existence of sound predictive theories related to issues in the humanities.

Secondly, the views represented by scholars in the humanities provide historical and contextual awareness**.** The lack of these in the current 'realist'

writing is troubling to many humanists. In the envisaged interface projects, the valuable contribution of the humanist would be to prevent eager experimentalists starting from scratch or reinventing wheels. This historical and contextual awareness most likely will come in the form of constraints imposed by culture. As Hart writes:

> Benefits accrue from the fact that recognizing species specific constraints on knowledge would have the same effect as recognizing constraints within any system: constraints beget structure, structure begets pattern, and pattern begets – more or less so, depending on the medium – complexity. Given the extremely complex media of human cultures and their cultural by-products, including literary texts, there is much potential *pleasure* to be gained from being able to glimpse and maybe even describe the kinds of patterns that can only become visible to us in systems that we once thought were, but now no longer envision as, operating at random. (Hart, 2001: 326)

Moreover, Hogan (2003), in the concluding chapter of his seminal book, says that humanists bring to the table nuanced understanding of the humanistic topics often lacking among cognitive scientists, whose discussions may tend toward the reductive or facile. In other words, cognitive science would benefit from deeper engagement with the humanists – in the understanding of how narrative works, the rhetoric of connections, and many other areas.

Finally, and slightly speculatively, interface projects that include both humanists and cognitive scientists carry greater weight and credence and have potential for attracting better funding than partial projects on the same topics construed within the traditional dualistic approach. After all, the metaphysical duality so ingrained in our human experiences is one of the cardinal problems facing scholarly works, and attempts at better understanding of this duality, for which the interface approach provides a platform, will surely speak to the humans who think about their undergraduate and graduate projects, the humans sitting on the panels of granting agencies, and the rest of the human population as well.

AN EXAMPLE OF AN INTERFACE PROJECT: TURN-TAKING IN CONVERSATIONAL INTERACTIONS

Human speech is a prime candidate for interface projects. Conversations are the fundamental means of living our lives. They are the means through which the various discourses are constructed as well as experienced. Conversational turn-taking is a cognitive embodied system that interacts with culture and discourse.

It is a cognitive system because it is governed by rules similar to other linguistic competences (Sacks et al., 1974), acquired unconsciously and without

explicit instructions just like many other facets of language. It has been reported that the norms and signals for turn-taking are acquired when children are two years old, even before they enter a two-word stage (Donahue, 1978). Turn-taking is also embodied since patients with some forms of aphasia (Wernike aphasia) are able to retain the rules of turn-taking despite the fact that their utterances make no sense and are not pragmatically cohesive (Schienberg and Holland, 1980) while other patients with brain damage (non-fluent aphasia, Parkinson's disease) suffer from significant decrease in turn-taking competence. Hence, turn-taking is closely linked to neuro-cognitive processes localized in various regions of our brains.

Turn-taking behavior is also clearly socially determined. The rules and conventions differ from culture to culture. Moreover, choices that we make in selecting when we speak have clear implications as signals of our social roles, positions of power, or other typical social categories such as age, gender or race. These choices, furthermore, reflect our degree of accommodation with the conversational partner(s) that may be driven by individual characteristics of the speakers but are inescapably couched in awareness of cultural discourses.

Broadly speaking, a turn-taking floor-management system must include: (1) ways of signaling and perceiving the cues for transition-relevant points and turn allocation among interlocutors (Sacks et al., 1974); (2) ways of achieving suitable length of latencies between the turns, avoiding long overlaps or silent pauses; and (3) ways of resolving disruptions in the system (Schegloff, 2000). Cognitive scientists bring to the table their understanding of perception and production modules of language and the constraints these place on our behavior. Phoneticians and phonologists are interested in capturing salient patterns in voice modulation and temporal management of our speech that are relevant for turn-taking. Computer scientists are interested in modeling the human–human interactions and approximating the human–machine conversations to them as closely as possible. Hence, they are able to identify some coarse patterns and understand how model conversations produced between humans and machines are perceived by humans. All scientists (cognitive, computer, phoneticians) have proven and tested ways of experimentation, identifying meaningful differences, formally modeling their best current knowledge, and testing those models against real-life observations.

At the same time, the culturally constructed and very nuanced, complex and multilayer structures of who speaks when, how it is determined and what implications it has for further development of the conversation belong clearly in the scope of the humanist's field. The humanist approach to data has the advantage that language patterns can be observed in their natural contexts, which provides much richer information than necessarily reductionist

quantitative analyses by the sciences. The quantitative approach inevitably abstracts away from a lot of data (that are inevitably continuous), typically has to assume a theoretical framework and tends toward conclusions that are simplistic and/or naïve. That is precisely why the humanist's point of view is so important. In the words of Davis, speaking about medicine and culture:

> If we took the advances the humanities have made over the past 20 years in developing complex ideas about race and applied them to medical research, much of the work already done on disease and ethnicity might have to change dramatically. That is because the current research standard in medicine and medical research for assessing race is based on the simple fact of self-reporting. But the interrogation of race in the humanities and social sciences indicates that race is a complex and multifaceted social construction, not easily translated to a check-off box. (Davis, 2007: B9)

The humanists in the interface turn-taking project bring the necessary cultural and historical awareness. They are in a position to ask tough questions about gaps in the formal models proposed by the scientists. By better understanding physical and cognitive aspects influencing the processes of turn-organization, the humanists may in turn gain a different perspective from which the data could be analyzed.

It is my belief that looking at conversational speech as a single system but with different levels of granularity would allow us to incorporate observations from a rich array of areas and thus cover more ground in our explanation. We can better understand discourse and how it 'shapes' us culturally if we see it as an emergent property of a non-linear dynamical system created through embodied interactions at other levels of the same system.

THE HUMANITIES IN THE 21ST-CENTURY UNIVERSITY: SUGGESTIONS

The work by Slingerland (2008), Hart (2001), Zunshine (2007), Fludernik (1996), Caroll (2008) and others, shows that scholars in the humanities are willing to engage with (some of) the advances of the cognitive sciences. The interface projects envisioned in this article require a critical mass of researchers who share some common principles and who can meaningfully communicate with each other. The example of the laboratory phonology community shows that an interdisciplinary project cannot be successful without sharing common methodological principles, working on maintaining common vocabulary, and sharing auxiliary theories applicable across disciplines, such as theories about instruments or statistical modeling. In this setting, the adoption of a particular theory or framework is less important, and the danger of falling into the Kuhnian paradigm trap is decreased.

Any interface project using non-linear dynamics must be solidly based on data collected and analyzed in rigorous fashion. The ingenious finger-wagging paradigm developed by Kelso is a useful example of how seemingly rudimentary observations and knowledge gained from analyzing data from simple experiments may lead to far-reaching models. But this has to start with data; more attention in the humanities needs to be paid to designing meaningful data collection paradigms, although they might not initially address big burning questions.

The meaningful communication to other fields of the data collected and analyses undertaken is extremely important. The majority of the work in the humanities is qualitative. There is nothing wrong with qualitative approaches as such, but it is problematic that in many cases the conclusions are supported only by positive evidence. This may decrease the value of the work in the eyes of other scholars because it is not clear if the selected positive examples are robust, how they were selected, and whether counterexamples exist. It is very tempting, and common in the sciences as well, to fall in love with beautiful insights that we gain after examining the data. But every effort must be made to give peers within and outside the field a better chance to assess the value of the work, and to allow for constructive critiques. Even if sections on methodology that fully and transparently describe the data collection and analysis might not be essential for the interpretation sections, they allow for the progressive accumulation of knowledge and will attract research questions from other fields.

In addition to greater responsibility for the data described above, potential interface projects would benefit from shifting the balance a little in the direction of quantitative research in the humanities. When scholars in humanities approach a problem or data, they should not discard the option that these could be approached quantitatively. Of course, not all questions yield to quantitative research, maybe not even a majority of them. But I suspect, following Gottschall (2008), who is a literary scholar himself, many important questions can be at least partially tested quantitatively. Qualitative and quantitative results complement and feed one another, creating new predictions to test or new patterns to fit into the theory. Moreover, if statistical methods of testing hypotheses are used, it is very likely that many assumptions in the humanities will not be validated, and that new, unsuspected patterns and insights will arise, as has been the case in any discipline that opened itself to statistical modeling. For example, as Gottschall describes, diagnosis in medicine has been considered an art for a long time and resisted the application of more quantitative methods and tests. Nowadays, some types of symptoms may require a more quantitative and others a more qualitative, gestalt approach, while both approaches crucially complement each other.

Continuing the medical theme, Pierrehumbert et al. (2000) discuss *syndrome* as a very useful concept for Laboratory Phonology. They adopt its definition as 'a characteristic combination of opinions, behaviors, features, social factors' and continue:

> In the history of the life sciences, discovery of a medical syndrome has repeatedly anticipated and shaped scientific theory by perspicuously uniting facts which point towards deeper conclusions. For example, the documentation of the Broca's and Wernicke's aphasia syndromes led the way towards present neurolinguistic theory. (Pierrehumbert et al., 2000: 282)

This notion of syndrome can be mutually beneficial for the humanities and sciences in their interface endeavors. On one hand, careful descriptive observations from several fields of the humanities may converge into a syndrome for which more experimental methods of sciences might be able to design a test. On the other, the accumulation of experimental observations from various sciences using diverse methodological approaches may identify syndromes relevant for questions in the humanities, as is the case in the embodied cognition results that I discussed above.

In this connection, humanities programs could consider designing a course in such research methods for its students, or making it obligatory if it already exists. Himmelfarb (1997) discusses such a course in history that she took in the past but which has been disappearing from the curriculum recently. Gottschall (2008) suggests obligatory statistics courses for the students in the humanities. There are signs that science students are interested in interface courses and programs. For example, about half of the students in natural sciences took a course in sustainability or the environment while only 28% of students in the humanities did so (Grasgreen, 2008). Hence there is hope that interface courses with strong participation by humanities scholars would attract students from both groups.

CONCLUSION

In this article I have argued that the humanities might gain intellectually stimulating avenues of inquiry, attract more funding and become more 'relevant' in the eyes of the general public if they consider interface projects with the sciences. I discussed a potential research framework of non-linear dynamics for this enterprise and I have argued that it alleviates some of the concerns scholars in the humanities might have, around the reductionism and determinism often assumed to belong to the scientific approach. I have provided some suggestions for adjustments that might make such interfaces more likely, with regard to transparent communication of data collection and analysis.

I have also argued that the idea of an interface with the sciences does not subtract from or reduce the scope of the humanities, but rather can open new perspectives, and aligning the work in the humanities with the rest of human knowledge will be beneficial for the universities and society in general.

Let me finish with two reactions of humanities scholars that I often hear and that express general concerns about interfacing with sciences. The first is the orange tree metaphor. In this, the tree represents the scope of inquiry for all disciplines. Sciences, according to this metaphor, want to take an orange fruit, peel it, squeeze it and thrash it, all in an effort to reduce it to physical components and the laws governing them and explain its existence this way. The humanities, on the other hand, try to see the beauty of the orange in its relation to the tree and the rest of the environment. To my mind, knowing more about the orange does not kill its beauty, but rather can make us more susceptible to aspects of its beauty that we would not know about if we did not dissect it. My second response (following Slingerland, 2008) is to argue that the orange tree is not a discontinuous collection of 'higher-level' leaves, branches and fruits. Rather, the tree should be seen as a beautiful, unified and complex system of roots, nutrients, circulation, chemical reactions and other phenomena at various levels that influence and are influenced by the leaves, branches, fruits and environment.

The second reaction is that the humanities are not trying to *explain* things; they try to make students *get* them, just like a joke. Getting a joke involves some kind of an 'aha' moment. The question then is whether that moment represents the connection with the 'platonic' abstract intangible world or whether the 'aha' moment can be construed as a switch from one stable cognitive state to a new one under the influence of a variety of observable, learnable and contextualized parameters. In this article I have argued for the second option.

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NOTES

1. Many scholars both within and outside the humanities would argue that the humanities are now in a state of crisis (Gottschall, 2008; essays in Kernan, 1997; Kronman, 2007). See also Cohen (2009) and Zuckerman and Ehrenberg (2009) for issues in funding, success in recent popularization of science, and also the perception that the humanities suffer due to their

culture of political correctness (Kronman, 2007), liberal and social activism (Bromwich, 1997), and post-modernism approach (Himmelfarb, 1997).

2. For example Kronman's (2007) view that science and technology breed ignorance about who we are and diminish our understanding of the human condition, or Menand's idea (Menand, 1997) that consilience between sciences and humanities is 'a bargain with the devil' (cited in Boyd, 2006 and Slingerland, 2008).
3. However, Hart herself acknowledges that even positions on the continuum are subject to the reiterations of the symptoms associated with the extreme realist/relativist positions. See also Caroll (2008) and responses to his target article for a discussion of the careful positioning of literary scholars as either eschewing or accepting the postmodernist epistemologies.
4. See Grasgreen (2008) on environmental studies program, the list of programs listed in Slingerland (2008), or Davis (2007) on a bio-culture program.
5. See for example Ceccarelli (2001) for a review.
6. Voiced obstruent sounds include plosives like {b, d, g}, fricatives like {v, z}, and other sounds.
7. S. Manning (in a personal communication) points out that in addition to pattern-searching, humanists are also occupied with searching for extraordinary, unique and novel expressions of thoughts or emotions where the critical task lies not in identifying the pattern, but in recognizing the exceptional nature of the expression of that pattern. This is of course true, but the exceptionality of such expression can in turn serve better to characterize the pattern through its novel exceptional features, or by rethinking the characteristics of the pattern itself.
8. M. Gladwel (2000) nicely shows how reaching critical values of control parameters such as cleanliness of subway cars achieves the formation of a new stable pattern in subway crime.

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