Fluvial geomorphology and semiotics: a Wittgensteinian perspective of the ‘divide’ between human and physical geography.

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# Abstract

This paper presents a broadly realist, pragmatist view of Geography, drawing on the work of Wittgenstein to consider the role of language in the divide between human and physical geography. The possibility that we may have ideas that are structured similarly but expressed differently is illustrated through the application of Peircean semiotics to a hierarchy of geomorphological processes in a river system. The resulting ‘scalar semiotic fluvial hierarchy’ allows some of the criticisms of hierarchy to be addressed, and offers geomorphologists a framework for understanding multiple cross-scale process interactions. Finally, the implications of a Wittgensteinian perspective for Geography are considered.

**Key words:** Wittgenstein; divide; fluvial geomorphology; hierarchy; semiotics; river bank erosion

The nature of the relationship between human and physical geography has been the subject of much discussion and debate in recent years. This paper presents a broadly realist and pragmatist view of Geography, drawing on the work of Wittgenstein. From this perspective, language is seen to be both a manifestation and cause of the divide between the subdisciplines, and particular insight into the nature of possible similarities and differences between the two is afforded. It is suggested that there may be commonalities between physical and human geography that are hidden by the language we use, and this is illustrated through the application of Peircean semiotics to a hierarchy of geomorphological processes in a river system.

**Wittgenstein: realism, language-games and forms of life**

In his later work,Wittgenstein (1953) emphasized the social nature of language, in that the sense of words is defined publicly, through the specific instancesof usage and common understanding (Scruton, 1981; Glendinning, 1998). He referred to the ‘total language’ used by any group of people as the ‘language-game’ of that group, arguing that the meanings of words are dependent upon the context within which they are used;

 “the mental experiences which accompany the use of a sign undoubtedly are caused by our usage of the sign in a particular system of language” (Wittgenstein, 1974a, 78).

Our understanding of the world is thus mediated through the language-game(s) with which we are familiar (e.g. Philips, 1977; Bloor, 1983). Many language-games exist, and Wittgenstein describes a multiplicity of language-games, but emphasizes a transience to them; new language-games develop, others may be modified or become obsolete. These language-games provide (or constrain) our opportunities for describing and explaining the world around us. Philosophy, religion and science, for example, represent different language-games, offering different possibilities for understanding the world. Whilst this may appear to present a relativist view of science, Phillips (1977) and Scheman (1996) suggest that Wittgenstein offers a compromise between relativist and absolutist views of knowledge.

From a Wittgensteinian perspective, observation is understood to be theory-dependent, and yet our language-games are constrained by the nature of the world around us (Sluga, 1996). As Westphal (2005, 310) puts it, “to have any point or use at all, the structure of our language must broadly comport with the structure of the world we inhabit.” To Wittgenstein, then, the constraining rules or conditions that are necessary for any sense to be made constitute our grammar, and so grammar goes beyond just words. Moyal-Sharrock (2003) illustrates:

“The hinge; ‘There exists people other than myself’ is an artificial expression of one of the grammatical conditions necessary for the use and understanding of the sense of such descriptive or informative statements as: ‘The world’s population doubled between 1950 and 1990’.” (133)

Thus a language-game consists not just of the words we use, but the meanings ascribed to those words within given contexts (meanings which are determined socially) *and* the conditions that allow language to make sense. Wittgenstein’s language-games are as much about our actions as about words, as it is our actions that underpin the sense we make.

“Children do not learn that books exist, that armchairs exist, etc. etc., - they learn to fetch books, sit in armchairs, etc. etc.” (Wittgenstein, 1974b, §476).

 “And to imagine a language means to imagine a form of life” (Wittgenstein, 1958, §19).

The notion that language-games are constrained by the world around us leads Westphal (2005) to identify Wittgenstein as broadly realist, in that there exists a reality external to us, in which objects have some characteristics regardless of our perception of them. However, rather than claims about whether or not we describe this reality ‘as it really is in itself’, Putnam (1995) reads in Wittgenstein an attempt “to try to make his reader *not want to say* either ‘we can describe reality, as it is in itself’ or ‘we can’t describe reality as it is in itself’” (40). The implication is that the notion of reality ‘as it is in itself’ is outside of the bounds of human comprehension, a nonsense. We cannot stand outside of our human language-games, our human forms of life.

**Academic language-games**

If the meaning of words is dependent upon the language-game within which they are being used, this can present difficulties for communicating ‘across’ language-games. In an academic context, this means language can act as a barrier between disciplines, a phenomenon that has been identified elsewhere. McNeill (1999), for example, specifies that inter-disciplinary research requires the “formulation of a uniform, discipline-transcending terminology” (314). Drawing on studies of academics across at least 30 disciplines (including Geography), Becher and Trowler (2001) note not only differences in language but associated “differences in the modes in which arguments are generated, developed, expressed and reported”(46) – in other words, differences in language-game. Rowland (2002) suggests that an increasing proliferation of both publications and specialisms, which could be interpreted as an increase in language-games, has decreased opportunity for critical debate among academics of different disciplines. Perhaps this is true of Geography, Johnston (2003) revealing that human geographers and physical geographers target (or ‘talk to’) different audiences in their publication practices. Making specific reference to Geography, Demeritt (1996) highlights the role that ‘inscription devices’ and ‘shop talk’ play in the construction of physical geography knowledge, suggesting that these restrict communication to a “narrowly drawn community” (495) whilst at the same time limiting our appreciation of the social elements in the work we do. In other words, our language-game has a significant role in defining ‘our reality’ – the bounds of our discipline, research methods and discourse.

Often we are not conscious of the assumptions embedded within our language-games.

“The aspects of things that are most important for us are hidden because of their simplicity and familiarity. (One is unable to notice something – because it is always before one’s eyes.) The real foundations of his enquiry do not strike a man at all. Unless *that* fact has at some time struck him. – And this means: we fail to be struck by what, once seen, is most striking and most powerful.” (Wittgenstein, 1958, §129)

One of the more specific, and perhaps most obvious, problems associated with the context-dependent meaning of words is that the same word may be used to mean different things, leading to misinterpretation among individuals who think they understand each other. Bracken and Oughton (2006) provide a considered account of this in the context of interdisciplinary research, and Bracken and Wainwright (2006) identify similar problems within a single specialism, discussing different meanings associated with the word ‘equilibrium’ among geomorphologists. The focus of this paper, however, is the possibility of the converse phenomenon: that parallel ideas may be expressed in different ways in different language-games. The application of Peircean semiotics to fluvial geomorphology, via the use of hierarchy, is intended to demonstrate this.

**Systems and hierarchies**

Checkland (1981) defines a system as an entity that maintains its identity throughout a range of conditions, and is composed of interacting, smaller entities (subsystems). He thus identifies hierarchical organization as a key characteristic of systems, as did Bennett and Chorley (1978) before him. Hierarchy theory has been applied to many contexts, from social systems (Koestler, 1967) to hydrological systems (Poole et al. 2004), from biology (O’Neill et al., 1986) and ecology (O’Neill et al. 1986) to ‘multi-disciplinary thinking’ (Kline, 1995). Given the pervasiveness of systems thinking in geomorphology, hierarchical perspectives are not uncommon (see Couper, 2004 for a brief review or De Boer, 1992 for more extensive discussion), nor are they in other parts of Geography.

It is important to be clear about the nature of the hierarchy under discussion, and it is nested (Koestler, 1967), scalar (Salthe, 2002) hierarchies that are of interest here. In such a hierarchy, each level contains (is composed of) the level below, with the individuals in that level being smaller-scale subsystems of the level above. ‘Scale’ refers to spatio-temporal size, although scalar hierarchies have been discussed in terms of space (De Boer, 1992; Newson and Newson, 2000) or time (Brunsden, 1996) alone, or through reference to process rates in ecology (O’Neill et al, 1986). For a system at any level of interest, the next higher level in the hierarchy provides the environment within which the system exists, defining its boundary conditions and constraints (Koestler, 1967; Bendix, 1994; Lemke, 2000). The system in focus in turn defines the boundary conditions of its lower level, smaller-scale subsystems. Opinions differ as to the capacity for ‘upscale’ influence, that is, the ability of a system to influence the larger scale metasystem within which it exists. Koestler (1967) suggests that relations between levels are unidirectional, the metasystem operating independently of the system, and Kondolf et al. (2003) reiterate this in the context of fluvial classifications, where similarity of climate, lithology, geomorphology and land-use history within a region will produce similarity in stream characteristics. Other geomorphologists (including Kirkby et al. 1996, Richards et al. 2002, and Roy and Lane, 2003), however, do indicate that smaller-scale, lower level dynamics can influence larger scale, higher level dynamics. Bennett and Chorley (1978) argue in favour of this upscale influence from a more abstract perspective, as does Lemke (2000). In what Lemke terms the ‘three-level paradigm’ of Salthe (1985; 1993), a system at any level in a hierarchy can only be understood through reference to both its higher-level metasystem and lower-level subsystems. Boundary conditions and constraints are provided by the metasystem, but as the subsystems are the constitutive individuals of the system of interest, the state of these provides the ‘initial conditions’ for system dynamics. There are thus autoregulatory relations operating in three directions within the hierarchy; regulation of smaller scale processes by the larger scale metasystem, interactions between individuals within a level, and upscale dynamics (Valsiner, 2004).

Hierarchical ideas have been influential within geomorphology, the most well-known being Schumm and Lichty’s (1965) ‘Time, space and causality in geomorphology’. The most explicit use of hierarchy in fluvial geomorphology is in the development of river classifications or typologies, often used for river restoration and management (e.g. Frissell et al. 1986; Rosgen, 1996; Dollar, 2000; Thoms and Parsons, 2002; Montgomery and Bolton, 2003). Among the many fluvial hierarchies proposed, similarities often exist in the scale levels used (for example, Newson and Newson’s (2000) ‘subcatchment’ and ‘reach’ seem to correspond to Thoms and Parsons’ (2002) ‘functional process zone’ and ‘repeated lengths of channel with similar channel style’), but none are identical. The existence of multiple proposals of fluvial hierarchies provides an indication that the idea is not uncontested. Doubts have been expressed regarding specific individual hierarchies (e.g. Miller and Ritter’s 1996 comments on the Rosgen, 1994, classification), the use of (hierarchical) classifications as an approach to river management (e.g. Simon et al. 2005), and regarding the utility of hierarchy in Geography more generally (Marston et al., 2005; Collinge, 2006). Two such criticisms appear to centre on definition of the hierarchical levels.

Firstly, in classifications of river systems, the focus of the hierarchy is often on geomorphological form (Kondolf et al., 2003). However, defining hierarchical levels by geomorphological form does not necessarily yield a process-sensitive typology; it may neglect the specific contextual circumstances of the individual case and fail to account for changes in (the existence of) specific landforms. This is particularly problematic if such a typology is to be used to determine management actions (Simon et al., 2005). Such criticism is not dissimilar from Marston et al.’s (2005) discussion of the ‘sites’ in human geography hierarchies, where they argue a need to recognize that sites always emerge from interactions or processes;

“…neighbourhoods are not discrete, permanent and linked ‘locales’, but the localized expressions of endo-events and exo-events, the ‘inside-of’ and ‘outside-of’ force relations that continuously enfold the social sites they compose.” (426)

Secondly (and relatedly), it is not always clear on what basis the levels (scales) in a fluvial hierarchy have been defined, or that they were defined according to consistent criteria. Newson and Newson (2000), for example, combine the phenomenological scales at which geomorphological processes operate with the sampling scales at which measurement is possible, in order to define what they term a practical hierarchy. Again, this parallels a problem with hierarchy in human geography identified by Marston et al. (2005); that predefined scales, determined by convention or perhaps by the availability of data, are then taken as given entities and so shape resulting explanation. However, Marston et al (2005) and Collinge (2006) offer this as a criticism of hierarchy, when it would perhaps be more productive to recognize this as a criticism of the way hierarchy is (mis)used. Both Marston et al. (2005) and Jonas (2006) comment on confusion surrounding the definition and use of ‘scale’. All of this begs for more careful consideration of the way geographers use hierarchy theory, the criteria by which levels in a scalar hierarchy are defined, and perhaps a more explicit acknowledgement that scalar hierarchies are conceptual tools to be tailored to the purpose and context of individual research problems.

**Semiotic Hierarchies**

One option for structuring a hierarchy is offered by Lemke (2000), who matches the triadic semiotics of Charles S Peirce onto the three-level view of a scalar hierarchy. To Peirce, a ‘sign’ is “something which stands to somebody for something in some respect or capacity” (cited in Chandler, 2002: p32). The sign thus consists of three elements, namely; the ‘representamen’, or form which the sign takes; the ‘interpretant’, or sense made of the sign, and; the ‘object’ to which the sign refers. The representamen mediates between the other two elements (Hookway, 1985). According to Quieroz and El-Hani (2006), Peirce also defined a sign as “a medium for the transmission of a *form* or the transference of a *habit* embodied in the Object to the Interpretant, so as to constrain the interpreter’s behaviour” (79, emphasis in original). Adapting triadic semiotics to a scalar hierarchy, Lemke (2000) proposes that phenomena at the level of interest are representamina (or signifiers) of ‘object-states’ of interactions of the lower level subsystems, for the higher level metasystem (which forms the system of interpretance). A semiotic ‘reorganisation’ of information occurs across the three levels, such that small-scale information at the subsystem level is integrated at the level of the system, and at this level becomes ‘meaningful’ for the metasystem. This triadic emphasis is important, as it allows recognition of cross-scale system interactions beyond a simple dyadic relationship wherein dynamics at one level respond to the next lower or higher level. The highest level (metasystem) does not respond to the dynamics of the smallest (subsystem) directly, as they occur on too small a scale to be of any consequence, but only when these small-scale dynamics have been reinterpreted by the intermediate-scale system. Lemke argues that this cross-level transfer involves typological information (differences in type) being reorganized as continuous topological variation (differences in degree), or the converse, between levels, resulting in an alternation of information type through the levels of the hierarchy. Such semiotic reorganization is, in his view, the key dynamical function of a level in relation to other levels in the hierarchy.

Whilst a number of authors are beginning to consider the application of semiotics outside of the social sphere, the notion that sign (or representamen), object and interpretant are universal categories applying to abiotic systems as well as biotic is the subject of some debate. There appear to be two key elements to this: firstly, definition of the ‘information’ that such semiotics might involve, and secondly, the requirement for semiotic systems to be anticipatory. The former will be considered here, returning to the issue of anticipation later in the paper.

Hoffmeyer and Emmeche (1991) define information as patterns (organization or form) of substance, adding that identification of information is based on ‘difference’ (citing Bateson, 1971). Distinguishing ‘difference’ necessitates some degree of selection, and whilst they do not entirely exclude the possibility of information use in non-living systems, they suggest that this would be at a cosmic scale and so of limited relevance to the semiotics of living systems. They thus limit their discussion of the ‘semiotics of nature’ accordingly. Kull’s (1998) work on ‘semiotic ecology’ makes no reference to non-living systems. To Joslyn (2000), a semiotic system involves interpretation, followed by decision between possible actions based on prediction of likely outcomes, thus implying that abiotic systems are not semiotic. However, as living systems evolved from abiotic systems, and all dissipative systems (living or non-living) “undergo essentially the same developmental trajectory, from immaturity to senescence” (392), Salthe (1998) questions the validity of drawing such a boundary. He concludes that the question is essentially ideological. Physical existence is said by Taborsky (2000) to entail closure (differentiation from everything else), and this closure occurs through the constraint of energy by codification. Such codification is, she argues, the most basic form of semiosis, as codified energy acts as information to other forms of codified energy. Using this ‘physical codification thesis’ (Emmeche, 1999), Taborsky thus links ‘information’ with energy and entropy (as does Campbell, 1982), allowing abiotic systems to be considered semiotic. Interestingly, Peirce himself is said to have been aware of potential applications of his semiotics to non-living systems (Hookway, 1985). Hoffmeyer and Emmeche (1991) identify a reluctance in the natural sciences to adopt ideas developed in ‘humanistic’ areas of enquiry, and it may be that such resistance, although unwritten, underlies some of the debate here. The focus on dynamical interactions between levels in Lemke’s (2000) semiotic scalar hierarchy, though, may be potentially useful in tackling the ‘scale issue’ in geomorphology, and thus warrants consideration.

**A semiotic hierarchy of the fluvial system**

The fluvial hierarchy described here is not dissimilar from others (such as those proposed by Petts and Amoros, 1996, Newson and Newson, 2000, and Thoms and Parsons, 2002), but is defined by focusing on the cross-scale dynamics and ways in which ‘information’ might be ‘reinterpreted’ between levels. It should be noted that this application of semiotics is not the same semiotic geomorphology discussed by Baker (1996), which focuses on the geomorphologist’s interpretation of geomorphological forms as signifiers of process. This kind of interpretation, arguably, is embedded within the description of the hierarchy, as it forms a central component of the language-game of geomorphology. The aim here is not to deny this, but to consider whether the fluvial system (as we understand it) can be portrayed as a semiotic system, and explore whether any new insights are yielded by describing the river system in terms unfamiliar to the usual language-game of geomorphologists.

The starting point for the development of this hierarchy was a survey of the (approximately 25km) length of the River Erme, Devon, UK, the purpose of which was to provide an initial picture of what bank erosion processes are occurring where on the river, to inform later study. The survey included observations of valley shape and the position of the river within this, the degree of coupling between channel & valley sides, the channel bed and bank materials, riparian vegetation, and evidence of bank erosion processes, quantifying uniform lengths of bank. Some field measurement of channel gradient was undertaken, supplemented with average gradients calculated from Ordnance Survey maps (1:25000 scale). The underlying geology was noted from the relevant British Geological Survey map.

A survey such as this has some limitations. Firstly, the identification of bank erosion processes relies entirely on the inference of process from form, and although relevant literature (particularly Thorne’s 1998 Stream Reconnaissance Handbook) was utilized, these inferences will be influenced by the experience and judgment of the surveyor. Secondly, the survey provides only a snapshot of the river at a particular time, although this is perhaps an over-simplification; interpretation of bank erosion process from form is essentially an interpretation of the last formative event on the bank, and the timescale between that event and the survey is both unknown and variable along the river. So the timescale of the snapshot is vague. Thirdly, prior experience suggests that subaerial bank processes do not always (probably not often) leave a characteristic form, and interpretation of bank erosion was thus limited to fluvial and mass failure processes. It seems likely that subaerial processes will be continuous (or quasi-continuous) on exposed areas of bank face (Lawler, 1991; Couper and Maddock, 2001). Finally, the survey was restricted to the channel named ‘River Erme’, neglecting tributaries. For the headwater tributaries this is not seen as significant, as they were visible from the main river valley and clearly similar to the Erme channel. The river has, however, one large tributary in the lower part of the drainage basin (the Sheepham Brook), and so the survey cannot necessarily be assumed to represent the entire river basin. Notwithstanding these limitations, some insight into the types and locations of bank erosion processes was gained, putting these into the context of the river as a whole.

Three ‘functional zones’ (hereafter referred to as zones) can be identified between the source and estuary of the river:

i) an upland zone on the Dartmoor granite, likely to be dominated by sediment production;

ii) a transfer zone, centred around a bedrock gorge as the river leaves the granite upland, and;

iii) a storage/delivery zone in the form of the lowland, alluvial floodplain river on the predominantly sedimentary lithologies of south Devon.

Within these, however, the river varies in character, such that seven ‘reaches’ have been identified. The definition of these is based on a combination of variables such as valley shape and gradient, underlying lithology, channel boundary materials, degree of channel and valley side coupling, and riparian vegetation. These seven reaches are described in Table 1, and three levels in the hierarchy have thus been identified; drainage basin, zone and reach. The rest of the hierarchy was subsequently constructed down-scale, focusing on river bank erosion processes. During the survey it was possible to discern, within reaches, discrete lengths of bank of uniform characteristics, i.e. uniformity of materials and morphology, perhaps yielding evidence of a particular type of erosion. The next level of the hierarchy is thus a ‘unit’, and it is assumed here that this is a length of bank on which a particular process/event of morphological significance occurs – that is, a length of bank subjected to subaerial, fluvial or mass failure erosion such that a consistent bank morphology results along that length. Units will thus vary in length, as indicated by Table 1. Equally importantly, the exact spatial definition of an individual unit may vary over time, as different sections of bank are subjected to different events; a unit may be split in two, or combined with a neighbouring unit, by the next event. Within the bank erosion literature, such events (or subaerial, fluvial or mass failure erosion processes in general) are often understood with reference to the constituent soil aggregates of the river bank, and specifically the stability of such aggregates, or resistance to imposed erosive forces (e.g. Thorne, 1990; Green et al, 1999). The soil aggregate thus provides the fifth level of the hierarchy. Soil aggregates can be understood through reference to their constituent soil particles, which in turn form the sixth level of the hierarchy. The resulting hierarchy of the fluvial system (focusing on river bank erosion) is presented in Figure 1.

The key to a semiotic scalar hierarchy, however, remains the relations between the levels. Whilst Figure 1 provides some explanation of these relations, it is useful to consider an example in more detail. In accordance with Lemke (2000) and Salthe (1985; 1993; 2004), three levels will be examined here. To take levels 3, 4 and 5 (the reach, unit and aggregate respectively), then, level 4, the unit, is the level in focus:

Relevant questions at the scale of the unit relate to the morphology of the bank, whether the bank is stable or eroding and, if eroding, the processes and pattern of processes occurring. In terms of the spatial and temporal scales used to study river bank erosion identified in Couper (2004), those studies at the ‘site’ scale are likely to correspond to this level of the hierarchy (e.g. Thorne and Tovey, 1981; Pizutto, 1984; Thorne and Abt, 1993; Simon et al. 1999). The state of basal endpoint control of the bank (Thorne, 1982) is relevant at the unit scale. These units of stable and eroding bank lengths, and the processes (where relevant) by which they are eroding, which could be argued to be typological variation, represent a synthesis of the continuous (spatial and temporal) variability in the state of soil aggregates within the units (topological variation), in terms of both within-aggregate stability and between-aggregate cohesion. The occurrence of bank erosion at the unit scale will be influenced by patterns of flow – discharge, velocity, primary and secondary currents – within the reach (e.g. Markham and Thorne, 1992), as these determine the (fluvial) forces to which the unit is exposed. However, the reaction of a unit to these forces will be pre-conditioned by the state of smaller-scale variation between aggregates. An example of this is the erosive effect of a flow event being influenced by subaerial weakening and weathering of the aggregates on the bank face, as first described by Wolman (1959). The unit thus has context from the reach level, and is influenced by the dynamics of and between the soil aggregates, the constituent individuals of the level below.

Looking upscale from the unit to the reach, the combinations of eroding and stable units of bank (typological variation) are synthesized at the reach scale into continuous variability (topological variation) of the locus and rate of meander development and migration. Meander development and bend curvature in turn influence the patterns of flow that provide the context for the unit level of the hierarchy, and a kind of ‘semiotic closure’ (Lemke, 2000) occurs. Such closure is, according to Joslyn (2000), integral to the formation and definition of a complex semiotic system.

Looking further up the hierarchy, the River Erme survey revealed that river bank erosion is focused in reaches 1-3 and 5 (Table 1). This is clearly influenced by the zone within which each reach is located and the function of this zone within the catchment sediment system; the three reaches within the upland, sediment production zone all display actively eroding banks. The only reach outside of this zone to display comparable (in fact, greater) proportions of bank erosion is reach 6, the lowland, alluvial river upstream of the tidal limit, where the river is actively reworking the floodplain. The dynamics of eroding and stable units within any one of these reaches has no significance at the zone scale unless, for example, the associated changes in channel planform pattern – meander formation and migration – lead to a different sinuosity and gradient for the reach, which may then influence the sediment production capability for the zone. Thus there is a ‘buffering’ of dynamics across any three hierarchical levels; information at the unit scale is of no significance to the zone, unless it is ‘re-interpreted’ at the reach scale to become ‘meaningful’ at the zone scale.

**Sensitivity, contingence and anticipation**

The cross-level buffering of dynamics suggests that the sensitivity of the river system to change takes a different form depending on where in the hierarchy the drivers of change originate. The sensitivity of a system at any given level (e.g. a unit in the hierarchy presented above) to the forces imposed from the next largest level (in this case, resulting from flow patterns within the reach) can be described by the force-versus-resistance notion of stability. The sensitivity of a system to the dynamics of the level below it, however, is more likely to be described by the occurrence of thresholds. Lemke (2000) explains this in terms of complexity and self-organisation, wherein lower-level dynamics become significant only when they cause a higher-level system to switch to a different attractor.

Contingence, the significance of a system’s history in determining its response to an input (see, for example, Lane, 2001) is also incorporated into the semiotic scalar hierarchy. One example of this has already been outlined above, in the reach-scale flow patterns being influenced by the channel planform resulting from the combinations of stable and eroding units that have come before. Additional examples may occur within a level; the response of a unit (length of bank) to a hydrological event will be influenced by the bank morphology left by the last formative event.

The semiotic scalar hierarchy as described so far, then, is compatible with some of the familiar concepts in geomorphology. Returning to the question of whether or not abiotic systems can be semiotic, it was identified earlier that some of this debate centres on the notion of ‘anticipation’. The role of anticipation in a semiotic system is, arguably, selection between possible actions/states. For both Salthe (1998) and Lemke (2000), this selection, or the determination of what actually happens, at any one scale is shaped by the state of the smaller-scale subsystems, the dynamics of which are more rapid. Thus Lemke (2000, 108) describes smaller-scale subsystems as the larger, slower system’s “way of feeling ahead into the future.” Essentially this seems to be an extension of contingence into the future: if the past conditions the present, then the present must condition the future. At ‘the present’ point in time, future possibilities of process and form at any one scale are already restricted by what is happening at smaller scales.

The crucial element here is ‘up-scale’ influence, and examples of this in fluvial geomorphology are not difficult to come by. Lane and Richards (1997) discuss both river braiding and flow turbulence in this context, whilst Eaton et al (2006) associate sinuosity and channel slope adjustments at the reach scale with shear stress and sediment transport at the scale of a channel width / cross-section. In this latter example, a localized perturbation in the river bed results in a feedback mechanism that propagates downstream, eventually leading to meander initiation and associated adjustment of channel slope at the reach scale. Future behaviour of the river at the reach scale, then, is (at least in part) pre-determined by the more rapid dynamics of the smaller scale processes and forms.

Some authors draw on the notion of ‘final cause’ to provide anticipation in abiotic systems. One of Aristotle’s four causes, final cause is the goal or purpose of a phenomenon/system, and has been largely excluded from western science since Galileo and Bacon (Trusted, 1991, Losee 1993). Final cause would provide further impetus for anticipation in a system, and differentiation between possible responses to ‘information’. Salthe (2004) invokes the Second Law of Thermodynamics, interpreted as the tendency of the Universe (as an isolated system) to equilibrate, as a final cause. However, the restriction of possible future states of a system by present (particularly smaller scale) dynamics, as described above, can be seen as a form of anticipation regardless of whether or not the idea of final cause is adopted.

The fluvial hierarchy presented here is clearly based on the empirical observations of the survey interpreted in the context of current ideas about river bank erosion processes and the variables influencing them. It is thus important to return to the semiotic elements of the representamen (sign), the object to which the sign refers, and the system of interpretance, to consider the consistency of assumptions underlying the relations between levels. In the hierarchy presented here, the representamen at every scale is a geomorphological process, and the ‘object’ to which this refers is an energy gradient driving the process. The system of interpretance is the larger-scale (higher level, metasystem) process that responds to (the signs of) smaller-scale energy gradients only when they (cumulatively) become significant for it.

Two criticisms of hierarchy outlined earlier focused on the definition of individuals/entities and the definition of scalar levels. In the semiotic hierarchy presented here, the entities at each level in the hierarchy are defined by our understanding of geomorphological process-form linkages: the forms are the emergent phenomena stemming from the processes in operation (see, for example, the definition of a bank ‘unit’ provided above, at Level 4 in the hierarchy). This corresponds to Raper and Livingstone’s (2001) ‘phenomenon instances’, dynamically constituted entities whose form, behaviour and even existence vary through time and space. The resulting hierarchy should thus be process-sensitive. The levels (scales) within the hierarchy have also been defined on the basis of (our understanding of) geomorphological processes, and specifically by considering the up- and down-scale interactions. The first attempt to construct the hierarchy included more levels, but some were subsequently rejected on the basis that they were meaningless in terms of processes and cross-scale process interactions. The important point here is that the application of hierarchy requires careful thought. The significance of the semiotic scalar fluvial hierarchy described in this paper is not so much in the specific hierarchy itself, which may not necessarily suit the focal processes of other geomorphologists’ research, but in the principle of defining scalar levels through reference to cross-scale transfer of ‘information’. This focuses the hierarchy consistently on our understanding of the dynamics of the system.

**Semiotic scalar hierarchies in human geography?**

The application of semiotics to a river system entails crossing the ‘divide’ from studies of human/social phenomena to physical systems. However, to further illustrate the point that human and physical geographers may be using parallel ideas, expressed differently, it is interesting to consider the possibility of applying the semiotic scalar hierarchy to social phenomena. The following, being written by a geomorphologist, is likely to be over-generalized, but the aim is to demonstrate some potential.

Traces of a semiotic scalar hierarchy can be seen in Smith and Kurtz’s (2003) account of the community gardens debate in New York City, which stemmed from the City of New York’s decision to sell 114 community gardens. In the political struggles that followed, there are at least four discernible scales of representation of the issue. Individual community gardeners were offered no formal opportunity to challenge the decision, but combined to form local gardeners’ coalitions, which were able to “respond to the local political structure of the neighbourhood” (203). The issue of individual gardens was thus re-interpreted to be a local community issue. Local coalitions were drawn into a city-wide gardeners’ coalition which (via news media and public discourse) framed the issue as a quality of life concern for the whole city, portraying the gardens as a vital ‘mosaic of green spaces’. This “moved the spaces of engagement well beyond individual neighbourhoods or community districts” (204). The citywide coalition was in a position to engage with the city’s political structure, for example by addressing the City Council’s Cultural Affairs Committee. The citywide coalition then extended the debate beyond the boundaries of the city by linking with other political struggles and “strategically associat[ing] the plight of the gardens with environmental concerns and a broader protest movement mobilized against the privatization of public space” (206-7). This reframed the issue as a public policy matter, bringing in other groups and politicians from beyond the City.

Smith & Kurtz (2003) thus provide sufficient detail to identify up-scale ‘reinterpretation’ of this controversy. They suggest, following Jonas (1994), that scale construction occurs through the struggle between dominant political actors endeavouring to exert control over weaker actors, and the subordinated groups finding ways to overcome these ‘containment strategies’. Such cross-scale interactions may be familiar territory for human geographers, but as with the fluvial hierarchy above, framing this as a semiotic scalar hierarchy could perhaps provide a context within which to examine up- and down-scale interactions across multiple scales simultaneously. This may also allow for the dialectical treatment of scale called for by Herod (1991), recognizing that “scale is not merely socially produced but is also socially producing” (84).

**The implications of semiotic geomorphology**

CS Peirce is perhaps most famous for the philosophical doctrine of pragmatism, which emphasizes the primacy of the practical:

“In order to ascertain the meaning of an intellectual conception one should consider what practical consequences might conceivably result…” (Peirce, 1906, 5.468 cited in Hookway, 1985, 326).

Wittgenstein, too, has been associated with pragmatism, although Goodman (1998) suggests that Wittgenstein both recognized and resisted this association. However, Putnam (1995) sees Wittgenstein’s later philosophy (that of *Philosophical Investigations* and *On Certainty*) as paralleling certain themes in pragmatism. Taking the pragmatists’ lead, then, it is important to consider the implications of the semiotic scalar hierarchy. These will be addressed first for fluvial geomorphology, and then Geography more generally.

In terms of fluvial geomorphology, re-representing the river system as a semiotic hierarchy (or attempting any other form of re-representation, for that matter), may hold potential for new insights. Wittgenstein referred to this as seeing an aspect:

“I contemplate a face, and then suddenly notice its likeness to another. I *see* that it has not changed; and yet I see it differently. I call this experience ‘noticing an aspect’.” (Wittgenstein, 1953, 193)

 “If you search in a figure (1) for another figure (2), and then find it, you see (1) in a new way. Not only can you give a new kind of description of it, but noticing the second figure was a new visual experience.” (Wittgenstein, 1953, 199)

Here the theory-dependence of observation is recognized, and yet again, interpretation is constrained by the world around us. As Baz (2000) argues, seeing an aspect involves expressing something that ‘fits’ what we see, and is “out there, open for anybody with an open eye to see” (107).

As the fluvial system has been presented here, the aspect that is illuminated is the multiple cross-scale interactions that constitute system dynamics. This emphasizes the need for appreciation of both the smaller- and larger-scale contributions to a process at any scale, and going beyond just the scale levels immediately above and below the focus of interest. This may, then, offer a useful framework within which to consider river management decisions and the possible consequences of any proposed management intervention. It also provides a reminder that the realist search for ‘underlying causal mechanisms’ should not necessarily be reductionist, a point as important for geomorphologists as Wight (2004) suggests it is for social scientists. Finally, the application of semiotics has been useful in terms of deriving a geomorphological hierarchy that is explicitly focused on our understanding of system dynamics, and is thus internally consistent.

The emphasis of Peirce’s pragmatism on the practical implications of a concept allows theories that are expressed differently to be identified as the same, if the implications of those theories turn out to be the same (Hookway, 1985). Peirce did, however, acknowledge that difficulties may arise if the proponents of the theories have no shared vocabulary within which to express these implications. This again draws us back to Wittgenstein’s language-games. For the discipline of Geography, it is interesting to note that portraying the river system as a semiotic system implies characteristics that ‘fit with’ familiar geomorphological concepts of sensitivity, thresholds and contingence. This reinforces the view that physical geographers and human geographers may have ideas that are structured in similar ways, although expressed differently.

The language-games of human geography and physical geography arguably have either a common history, or common elements in their histories (Matthews and Herbert, 2004), as the language-game of Geography. In Wittgenstein’s words, they have a ‘family resemblance’ (Wittgenstein, 1953, 32). Members of a family do not look identical, but there will be any number of resemblances between them – and not necessarily in the same features between all members of the family. It is likely that there are family resemblances among the language-games of many academic disciplines and subdisciplines, such that physical geography shares some features with physics and human geography shares some features with sociology (as indicated by the ‘physics envy’ and ‘social envy’ discussed by Massey, 1999; 2001 and Lane, 2001). Identifying such resemblances in the language-games of physical geography and human geography must surely increase the possibility of finding instances where we can incorporate each other’s ideas – cross, or even integrate, language-games – without abandoning the concepts we have adopted or developed separately. Three possibilities for such resemblances spring to mind:

• Resemblance in logic or argument, in the structure of ideas. This paper provides one such example, where ideas familiar to geomorphologists are seemingly compatible with the usually more human-focused semiotics, but have not previously been expressed in such language.

• Resemblance in terms of the focus of interest. Matthews and Herbert (2004) identify themes of space, place, environment and maps as common to both sides of the divide, but again, these may be discussed in different ways, using different language.

• Resemblance in the words we use, but with different interpretations of these words. Alongside the examples alluded to earlier, ‘scale’ appears to be a particularly contentious term, with multiple definitions and confusion being identified across both human geography (Marston et al. 2005; Jonas, 2006) and physical geography (Curran et al. 1997; Kavvas, 1999; Zhang et al. 2004).

If such family resemblances do exist, though, the problem remains one of identification, given that we may be using different language or understanding the same words differently. The exchange between Massey (1999; 2001), Lane (2001) and Raper and Livingstone (2001) illustrates this. Massey (2001) reveals an awareness that her interpretation of the writings of the other authors, influenced by the context of her background in human geography, may not match the meanings they intended, writing within the context of their differing backgrounds. An equally problematic, and related, issue lies in the possibility of ideas being ‘twisted in translation’, if a concept is utilized without a full understanding of the context from which it came (see Thorn’s 1988 discussion of ergodicity for an example of this). This perhaps is less important if we are simply looking for new insights within our own specialism, but of more consequence if we want to integrate.

**Conclusion**

To conclude, Wittgenstein affords a view of human and physical geography that acknowledges both our differences and our similarities, and effectively negates the question of whether Geography is one discipline or two. A Wittgensteinian perspective offers potential for further exploring and understanding the relationship between the two sides of the divide, as language-games with family resemblances. Three likely areas of family resemblance have been suggested here, in the structure of ideas, foci of interest, and terms we use. A purposeful investigation of these could yield prospects for further ‘conversations across the divide’, although such investigation would be no easy task. There may be other family resemblances yet to be identified.

Such family resemblances may allow us access, even if only partial, to each others’ language-games. This, in turn, can enable us to ‘see an aspect’ – develop a new perspective – in our own. This has been illustrated here by applying semiotics to fluvial geomorphology, which forced close attention to the definition of entities and scales in a fluvial hierarchy. The result is a scalar hierarchy that makes some sense of the multiple cross-scale dynamics that geomorphologists are faced with, as well as addressing some of the recent criticisms of hierarchical perspectives. Such opportunity to learn from each other should not be dismissed lightly.

In recent years a number of researchers have discussed possibilities for increasing integration of human and physical geography (e.g. Massey, 1999; Urban and Rhoads, 2003; Richards, 2003 and in Harrison *et al.* 2004; Herbert and Matthews, 2004). Generally, these seem to prioritize a focus on processes, relationships and interactions between phenomena as holding the greatest potential for developing a more integrated view of the world with us in it. The application of semiotics explored here shares this emphasis, offering further support to their arguments.

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**Table 1: Seven reaches of the River Erme.** Note that ‘left bank’ and ‘right bank’ are defined whilst looking downstream. For simplicity, the channel length of the reach displayed here is an approximate length, based on the mean measured length of the left and right banks for that reach.

|  |
| --- |
| **Reach 1** |
| *Approx. length:* 2050m | *Average gradient:* 0.026 |
| *Lithology:* Granite; some alluvium in valley bottom |
| Single-thread, highly sinuous, gravel-bed stream located in a wide, roughly symmetrical valley with flat, largely wet valley floor indicating a high level of surface water storage (influenced by the underlying granite). Valley sides are convex and appear quite stable, with a low degree of channel/hillslope coupling. Sediment availability will have been influenced by Quaternary periglacial processes and by the widespread occurrence of tin mining in historic time. Remnants of the tin working are apparent in a number of locations. Present-day land use: open moorland, used for grazing.River banks predominantly (85% of left bank length, 95% of right bank length) consist of a dark, peaty, organic material. Bank height is commonly around 1m. Significantly undercutting (e.g. to 0.5m behind bank face, occurring approximately at water level) in many places. 10% of the left bank length and 13% of the right bank length show evidence of erosion. Bed sediments are coarse.Number of bank ‘units’: left bank = 21; right bank = 37 |
| **Reach 2** |
| *Approx.length:* 3700m | *Average gradient:* 0.027 |
| *Lithology:* Granite; some alluvium in valley bottom. |
| Less sinuous, deeper, predominantly single-thread channel. Valley shape is largely symmetrical, with the channel meandering from one side to the other. A higher degree of channel/hillslope coupling than in Reach 1, with valley side instability seemingly caused by undercutting of the river in two or three locations. The channel is confined to some degree by the valley sides, and the presence of boulders may operate as a further local constraint on lateral activity. Boulders litter the valley sides, forming possible stone stripes in one location. Present-day land use: open moorland, used for grazing.Banks are dominated by boulders with a matrix of clay/silt/sand. Bank heights range from 0.6 to 2.25m. Evidence of erosion is visible along 4% of the left bank length and 14% of the right bank length. River bed sediments are predominantly coarse (gravel/sand), with some bedrock outcrops and boulders.Number of bank ‘units’: left bank = 21; right bank = 41 |
| **Reach 3** |
| *Approx. length:* 6400m | *Average gradient:* 0.025 |
| *Lithology:* Granite; some alluvium in valley bottom.  |
| The upper part of the reach is characterised by a symmetrical valley with narrow valley floor, and some mature vegetation. (The valley shape in the lower part of the reach was difficult to discern due to mature riparian vegetation). Land use is largely agricultural (grazing).The channel is predominantly a bedrock- and boulder-bed channel, incised into the rock in places. The bank materials largely consist of boulders (87% of left bank length and 78% of right bank length) and non-cohesive sediments. Bank heights range from 1-3.5m, though predominantly at the lower end of this. Evidence of bank erosion was recorded along 2% of the left bank length, and 10% of the right bank length.Number of bank ‘units’: left bank = 7; right bank = 4 |

Table 1 (continued).

|  |
| --- |
| **Reach 4** |
| *Approx. length:* 950m | *Average gradient:* 0.039 |
| *Lithology:* In downstream order: Carboniferous Culm Measures; Middle Devonian slate. |
| An incised, bedrock channel with low width:depth ratio in a narrow, steep-sided valley. The steepest part of the reach has a gradient of 0.075. The river bed consists of boulders and gravel in the lower part of the reach, though with bedrock still visible in places. Land use is predominantly urban (as the river passes through the town of Ivybridge). Over 70% of the lengths of both left and right banks are bedrock, the remainder being boulders and some artificial boundaries (walls). Number of bank ‘units’: left bank = 1; right bank = 1 |
| **Reach 5** |
| *Approx. length:* 4200m | *Average gradient:* 0.018? |
| *Lithology:* In downstream order: Quaternary river gravel & head; Middle Devonian slate; Igneous schalsteins & tuffs |
| Wide, shallow channel in a wide, approximately symmetrical valley with floodplain (little or no channel/valley side coupling). Narrow band of mature riparian vegetation. Land use is predominantly agricultural (pasture). River bed varies between bedrock, boulders and coarse sand/gravel with some bed features (e.g. bars) where the sand/gravel occurs. River banks are predominantly bedrock or boulders, with some artificial confinement of the channel in places. Evidence of bank erosion is negligible.Number of bank ‘units’: left bank = 1; right bank = 3 |
| **Reach 6** |
| *Approx. length:* 3450m | *Average gradient:* 0.0018? |
| *Lithology:* In downstream order: Middle Devonian slate; Lower Devonian Staddon Grit (grits & slates); Meadfoot Group (slates with grit). |
| A meandering, gravel/sand-bed, lowland floodplain river with cohesive banks. Valley shape is largely symmetrical, with a low degree of channel/hillslope coupling. Land use is agricultural pasture. In-channel features include riffles, pools and bars. Evidence of bank erosion recorded along 20% of the left bank length and 32% of the right bank length.Number of bank ‘units’: left bank = 14; right bank = 35 |
| **Reach 7** |
| *Approx. length:* 3900m | *Average gradient:* 0.0021? |
| *Lithology:* In downstream order: Lower Devonian Staddon Grit; Meadfoot Group; Dartmouth Slate. |
| Tidal zone. Meandering river in symmetrical valley. Some confinement of the river by the valley sides in the lower part of the reach. Land use is agricultural pasture (in the upper part) and woodland (lower part of reach). Occasional bedrock outcrops occur around the channel edge. Wetland areas indicate deposition of sediment. Some evidence of bank erosion occurs in the upper part of the reach, but in terms of proportion of bank length this is negligible. Number of bank ‘units’: left bank = 3; right bank = 1  |

**Figure 1: scalar semiotic hierarchy of the fluvial system, focusing on river bank erosion**

