Wide coding

Tetris, Morse and, perhaps, language

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Abstract

Code biology uses protein synthesis to pursue how living systems fabricate themselves. Weight falls on intermediary systems or *adaptors* that enable translated DNA to function within a cellular apparatus. Specifically, code intermediaries bridge between independent worlds (e.g. those of RNAs and proteins) to grant functional lee-way to the resulting products. Using this Organic Code (OC) model, the paper draws parallels with how people use artificial codes. As illustrated by Tetris and Morse, human players/signallers manage code functionality by using bodies as (or like) adaptors. They act as coding intermediaries who use lee-way alongside "a small set of arbitrary rules selected from a potentially unlimited number in order to ensure a specific correspondence between two independent worlds" (Barbieri, 2015). As with deep learning, networked bodily systems mesh inputs from a coded past with current inputs.

Received models reduce 'use' of codes to a run-time or program like process. They overlook how molecular memory is extended by living apparatuses that link codes with functioning adaptors. In applying the OC model to humans, the paper connects Turing's (1937) view of *thinking* to Wilson's (2004) appeal to *wide cognition.* The approach opens up a new view of Kirsh and Maglio's (1994) seminal studies on Tetris. As players use an interface that actualizes a code or program, their goal-directed (i.e. 'pragmatic') actions co-occur with adaptor-like 'filling in' (i.e. 'epistemic' moves). In terms of the OC model, flexible functions derive from, not actions, but epistemic dynamics that arise in the human-interface-computer system. Second, I pursue how a Morse radio operator uses dibs and dabs that enable the workings of an artificial code. While using knowledge ('the rules') to resemiotize by tapping on a transmission key, bodily dynamics are controlled by adaptor-like resources. Finally, turning to language, I sketch how the model applies to writing and reading. Like Morse operators, writers resemiotize a code-like domain of alphabets, spelling-systems etc. by acting as (or like) bodily adaptors. Further, in attending to a text-interface (symbolizations), a reader relies on filling-in that is (or feels) epistemic. Given that humans enact or mimic adaptor functions, it is likely that the OC model also applies to multi-modal language.

Keywords : Organic codes, distributed language, adaptors, wide cognition, reading, languaging.

1.0 Introduction

Protein synthesis offers a paradigm of how living systems use codes to self-fabricate. In this paper, I use code biology to emphasise multi-scalar temporalities –how biological systems use syntheses based on a *bridging* between independent worlds (e.g. DNA and the cellular milieu). Having done so, I turn to how artificial codes prompt humans to self-fabricate as (or like) adaptor-systems. We too can draw on sets of "arbitrary rules selected from a potentially unlimited number in order to ensure a specific correspondence between two independent worlds" (Barbieri, 2015) or, specifically, computer programs and codes such as Morse. The paper argues that, in drawing on such codes, we use one of living nature's oldest tricks. Humans link multiple inputs to fine-tune in ways that link past and present to bring about action readiness. Bodies are able to develop functions that are, at very least, adaptor like.

The paper focuses on the role of adaptors in coding. First, these are described in relation to organic coding (OC) and then the OC model is applied to adaptor function in general. It is stressed that, in protein synthesis, bridging between worlds allows an adaptor system (e.g. transfer-RNAs) to link translated DNA to the ribosomal apparatus that allows for flexible functionality. Far from being mechanistic, the adaptor is a coding intermediary[1] that gives the system lee-way. This arises because, just as in deep learning, synthesis can use multiple inputs: an adaptor uses a lineage memory based in DNA copying. The process thus links relations and materiality in ways that are inconceivable on a received model of codes. This is because, while open to formal description (i.e. by arbitrary rules that allow for correspondence between two independent worlds), organic coding draws on the multi-scalarity of life. The received view of codes mistakenly abstracts formal rules from bodily function (making covert appeal to hardware and universal Turing machines). As humans act in adaptor like ways, they not only use artificial codes (as described by the received model) but, in so doing, they use multi-scalar inputs to self-construct skills. The case is made, first, for Tetris and, later, for how an operator sends signals in Morse. In both activities, multi-scalarity allows for skills that go beyond formal run-time description. Like adaptors, persons use what, as a first approximation, Antonio Damasio (1999) calls the *feeling of what happens*. In what follows, I thus seek to clarify why felt-involvement matters in cases like playing Tetris and sending signals in Morse.

One can question whether persons *really* act as adaptors. To avoid this question, I stress that coding-by-use-of-adaptors is a 'simplex' trick akin to the ubiquitous use of networks, inhibition, neural re-use or the detour principle (see, Berthoz, 2012; Gahrn-Andersen & Cowley, 2018). Plainly, many molecular codes use adaptors. Thus, even if humans merely act *like* such systems, the parallel has power. While my focus is on the use of Morse and Tetris, the paper illustrates the power of the argument in brief discussion of *writing* and *reading.* As in Morse signalling, a writer resemiotizes by using code-like alphabets and/or idiographic and/or numerical systems.[2] A body-in-an-environment writes in fine-tuned anticipative ways. The claim thus challenges the received view that writing is a way of assembling (stored) linguistic 'knowledge.' Not only do standard views strip embodiment away from text-making, but they overplay run-time (as if we only re-write what we have already formulated). Further, such views overlook the asymmetry between how adaptor like systems are involved in synthesizing and enabling. Thus, while Morse signalling and writing *actualize* codes (as living wetware synthesises), reading or Tetris are strictly code *enabled*. An actor uses an interface/surface that links already-ascertained knowledge/beliefs (in Tetris, she makes 'pragmatic' moves) with filling in that leaves lee-way. Using experience, she anticipates valuable uses of the text/display (in Tetris, the moves are 'epistemic'). Far from encoding linguistic *abstracta*, alphanumeric or idiographic symbolizations function as formulae that aid intelligent work (by a reader or writer). Just as no player knows a Tetris program, one need not know how phonetic/bodily gestures connect English 'words' with beliefs, attitudes, affect and identity. Indeed, the OC model offers suggestive views of how languaging (i.e. activity in which physical wordings play a part) co-evolves with code-like alphabetic, ideographic and numeric systems.

2.0 Coding: biology and cognitive science

In linking code biology with cognitive science and languaging, the paper attempts a balancing act. It treats organic coding as a fact –many, perhaps all, molecular codes use adaptors. At very least, these coding intermediaries drive the protein synthesis of every living cell. Accordingly, the coding rules of DNA function

[1] This term was suggested by an anonymous referee.

[2] Resemiotization is usually defined as the translation of social processes between media (see, Idema, 2003). In what follows, I emphasise that unique impressions or events can be granted form as functional pattern that is perceived as repeatable or, perhaps, as having perduring form.

as part of a functional protein system that sustains the cell. The code serves not only copying (or replication) but also in epigenesis and metabolism. Adaptors draw on a lineage as an organism self-constructs and self-maintains. The process is anticipative and sensitive to environments on both sides of the skin. Adaptors leave lee-way (or wriggle room) that allows for selection by exploring the not-impossible. Given code intermediaries, this lee-way opens living systems to novelties. At a molecular level, minor variations in the frozen genetic code permit the diversity of living species. In humans, adaptor mechanisms grant flexibility with code-use (and, presumably, in using physical invariants) as plastic brains link neural re-use with the experience that shapes organism's action-readiness. Human cognition is embodied and, at once, uses the world beyond the body: cultural history fine-tunes multi-scalar cognitive processes and how a person manages social subjecthood (Madsen, 2017).

Some may find the OC model disconcerting. First, the origins of cognitive science lay in using computational models to clarify mental function. Work built on a received view of *codes* and, in the early years, language or vision were modelled as functions based on hardware. In line with changes since the 1990s, the OC model allows that self-fabrication defies von Neumann computation. In parallel, cognitive science has turned to embodiment and, recently, the enactive-ecological focus on organism-environment coupling has challenged all appeal to (inner) representations. In this context, the OC model is bound to seem disconcerting. While not based in representation, its multi-scalar emphasis stresses that living systems re-use ('represent') past experience. Further, rather than follow enactive-ecological scholars who focus on affordances, structural coupling, sense-making or task-specific devices, it deflates the role of (run time) interaction. Rather cognition is traced to bio-mechanisms that trigger changes in anticipative functions. While interaction matters, living systems also integrate events at scales ranging between those of molecular processes and ecosystemic evolution. In applying the OC model to humans, I give special weight to culture and, specifically, what Wilson (2004) calls *wide* processes. Today, building on the seminal work of Hutchins (1995), such views are widely held. Human intelligence uses how systems are distributed in space and time – and these include what we call *language*. The consequences of allowing that language is distributed are far reaching (for discussion, see Cowley, 2011; 2014; Thibault, 2011). First, languaging becomes, above all, a mode of multi-scalar coordination that links bodies across materials, space and time. Second, people need –not stores of words and rules –but ways of using the 'said' to engage with each other and the world. In turning to experience, talk and practices, languaging is found to centre on networked bodies (not words). Third, in rejecting organism-centred views human living and cognizing can be traced to a history of languaging and, inseparably, the evolution of culture. Indeed, it points to the hypothesis that languaging uses powers that arise as human agents self-fabricate as controller-adaptors.

While motivated by a distributed perspective, the paper's central argument builds on use of codes in Tetris and in Morse. Using the OC model, I link both well-known observations with remarks on how code-use sustains human activity. Centrally, I stress how the organic coding (OC) model (see Fig. 1) places importance on adaptors. Whereas DNA has long been frozen, adaptors share the evolutionary history of lineages (across species, populations and individuals). These rely on coding intermediaries –in protein synthesis, tRNA bridges between independent worlds (e.g. DNA and a cellular milieu). Since other signals (e.g. messenger RNA) influence the synthesis, the adaptor allows for contextual sensitivity. The signature of an adaptor is *how* it bridges between worlds by setting up sustained but intermittent contact with an interface (or similar intermediary). The same kind of contact appears in Tetris and in sending Morse signals (and, indeed, in seeing and talking). Crucially, a synthesized protein's function is neither determined (e.g. by the DNA code) nor wholly determinate (i.e. for the cellular milieu). Rather, the manufactured product is available for variable kinds of use. Given that adaptors grant lee-way to code-processes, they offer a creative influence to the explorations of evolving systems.

The OC model challenges the received view of codes as rule-governed systems. This is illustrated by focusing on how players/signallers use intermittent and sustained contact in Tetris of Morse. I show how such action bridges a person's 'world' with an independent code-using device. Bridging arises as persons judge/make moves of likely value: the moves *are* action. While readily *described* as interpretation (based on 'knowing') functionality depends on connecting parts (e.g. apparatus with adaptor). As people perform in Tetris or Morse, they monitor-and-act as they feel, perceive and act. Far from 'interpreting', they engage actively with a Tetris interface or Morse transmission key. They use embodied sensitivity in a domain that *includes* personhood, devices, interfaces, and messages. Artificial codes use systems that incorporate human users. Remarkably, Alan Turing (1937) took a similar view. Far from taking a computational model of mind, he conceived of thinking as *literally* extended by calculating. Recently, similar 'extended' views have come to be shared by cognitive models that stress brains (see, Rupert, 2009), self-organising networks (see, Anderson, 2010) and bodily coordination (see, Chemero, 2011). My focus turns from embodied interaction to how bodies-in-systems act as (or like) apparatuses and adaptors. Leaving aside brain/body dualism, artificial codes are traced to what Wilson (2004) calls *wide cognition*. In using Tetris or Morse to build and exercise skill, human actors use wriggle room that elicits results and, as they do so, they gain skills that can serve in future play. In becoming skillful, they may eliminate the lee-way (and build a routine) or, indeed, develop a 'way of acting'. Given this variability human parts differ from software patches or other add-ons. Rather, acting can be compared to how a blind man's cane becomes "an area of sensitivity" that acts in parallel to sight. In a famous example, Merleau-Ponty stresses how it extends "the active radius" of touch (Merleau-Ponty, 2000; 143). This perceived unity, is, I argue, akin to the cell-like closure lived by users of Tetris or Morse: players act within a wide system or a familiar world.

Although the OC model clarifies adaptor functionality, the examples of Morse and Tetris differ. Whereas organic coding uses evolutionary history to link independent worlds, Morse and Tetris rely on human design. This truism has an important consequence. The physical *enabling* required by artificial codes lacks any organic counterpart (cells implement metabolism). Tetris is enabled by a program on hardware (a device lacking a natural equivalent). However, in Morse signaling, hardware depends on the radio operator' use of dibs and dabs. In enabling its use, the operator does more than implement rules: he or she links a history of training, an attuned bodily apparatus and ways of controlling action readiness. Skills with a transmission key draw on fine phenotypical control. In Morse signaling, a human code intermediary uses sustained but intermittent contact with an independent transmission-receiver system. Tetris is, in this sense, more like organic coding. Since a Tetris player does not know the program, a player actualizes (and derives) skills through repeated contact with an interface: the player's strategies draw on using the body as a whole (as a control apparatus) while adjusting to the changing Tetris environment (viz. like a bodily adaptor). In the latter case, the person is a code intermediary. The value of varying action readiness is discussed below and, in section 4.3, literacy is discussed around the enabling/actualizing distinction in ways that are both illuminating and, perhaps, have consequences for languaging in general.

3.0 Code biology reaches out

Application of code metaphors to living systems drew, first, on computation and, second, on a view of language. Roman Jakobson's use of linguistic metaphors to describe DNA strings has been traced to discussion between renowned scientists on French television (see, Markoš & Faltýnek, 2011). After François Jacob endorsed the metaphor (see Jacob et al., 1968), many unthinkingly accepted that molecular processes are reducible to genetically encoded information. Often, this was taken to parallel algorithm use by software. In adopting this 'received' view of codes, a linear arrangement of symbols came to be used as a source metaphor whose target was genetic structure.

Code biology denies that living reduces to encoded information or biochemistry (Barbieri, 2019). By treating protein synthesis as an exemplar, emphasis falls on adaptors. Instead of identifying molecular codes with mere sequences of symbols, metabolic processes become a source metaphor: physical and biochemical contact connects organic memories (e.g. DNA code), an apparatus (e.g. ribosomal RNA complexes) and adaptors (e.g. transfer-RNAs) that synthesise protein. A cell's self-fabrication uses an evolutionary history that is preserved through codes, apparatuses and coding. In Barbieri's terms (in press), "The genetic code is an integral part of the apparatus of protein synthesis, and yet there is a profound difference between the evolution of the code (*adaptors*) and the evolution of that apparatus. The genetic code has been highly conserved since its origin almost 4 billion years ago, whereas the apparatus of protein synthesis has continued to change" (Barbieri, in press, section 10). In reflecting this history, the OC model distinguishes the environment, the cell, the apparatus as a whole, and how adaptors use intermittent but sustained contact with the translated code to bridge between independent worlds. While using DNA, living systems use many other means to self-sustain and, indeed, expand their scope. In slower scales, much depends on mutation, selection and, generally, intra-cellular change; in faster ones, protein synthesis is intrinsic to metabolic control. In this multi-scale temporal process, translations of coded material co-function with adaptors. Using the closure of a cell, one need no criteria for interfaces, output or interpreters. This is shown in the simplified OC model of Figure 1 below.

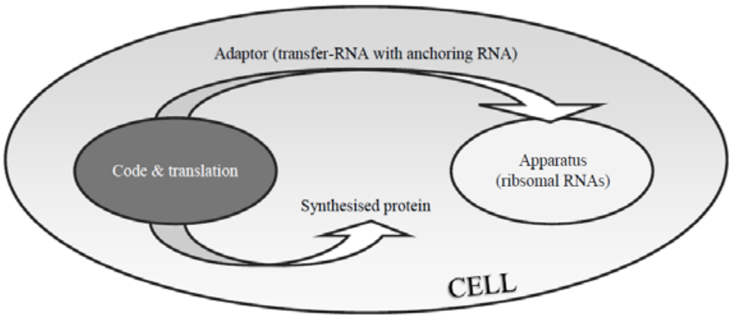

Fig 1. The OC model.

The OC model is later applied to how artificial codes use the enskillment of human bodies. By hypothesis, human experience draws on experience to self-fabricate systems that grant different kinds of functionality. In terms introduced above, as adaptor-like, humans become code intermediaries who attune to perceived translations at an interface (in Tetris) or in deriving signals from script (in Morse). However, they also develop as apparatuses that can exert whole-body control (based on 'knowing' the rules or 'how to play' the game). Since these powers link skills with expertise, they are cognitive. Even sending signals without understanding (as in operating in Morse) relies on acting in ways that (inadvertently) prevent and reduce errors. All being well, the system's lee-way enables a person to self-fabricate adaptor-like ways of effective acting.

3.1 Tetris, Morse and existential meaning

The received view of a code allows the picture that, like software, mind supervenes on the brain. While some still think that brains identify, store and manipulate linguistic symbols, today, no-one posits that they use a Von Neumann architecture. Brains use neither a central processor nor separate out memory, data storage and algorithmic transforms. Cognition is irreducible to what Susan Hurley (2008) wryly called the filling of an input-output sandwich. Just as in biology, symbol sequences are poor models for mental states. In linguistics too, ever fewer ascribe language to an a priori 'language-system'. Challenges to code views (see, Reddy, 1979; Harris, 1981; Sperber & Wilson, 1986; Love, 2004; Kravchenko, 2007) have led to ways of viewing language as coordination, embodied interaction and languaging (see, Cowley, 2011). To bring the OC model to human action is thus to allow understanding that presupposes neither interpretation nor, indeed, a corresponding inner process (Wittgenstein,1958 §580).

The OC model allows one to test predictions about code-based system function. While a focus on adaptors and context sensitivity makes it non-mechanical, the model allows for functional (or other kinds of) decomposition that identifies parts and processes. Since these co-evolved within the cell, there are limits to parallels with artificial coding. As humans did not co-evolve with computers, telegraphy or printing, any application of the model presupposes a form of closure that functions like a cellular membrane. As with Merleau-Ponty's (2000) blind man and stick, performance must use feelingful movements: in Tetris or Morse, a human must act as if one is in control even if, like the blind man, one relies on a circular process of bodily sensation. So how can a person be fully immersed in a larger system?

Antonio Damasio (1999) appeals to the *feeling of what happens*. Using neuroscience, he stresses how a living person responds as s/he notices aspects of the world: the feeling of what happens *is* noticing cum response. In Tetris too, noticing/action is part of the game. However, while Damasio highlights the brain, my focus is on pre-reflective and pre-predicational activity: felt-involvement (not noticing/reacting) shapes events. In Gahrn-Andersen's (in press) terms, this becomes *existential meaning* that is intrinsic to the "sense-saturated coordination" of human action. It grants a feel to situated involvement and is necessary to perceiving something as having particular properties.[3] Existential meaning in instrumental in, for example, choosing between beers, giving a tone to one's speech or, indeed, dislodging chicken from the teeth. In each case a careful third person observer may choose to invoke 'noticing' and 'reacting.' Yet, the felt-involvement is far too fast for deliberate first-person control. In the case of the chicken, talk and/or dining may accompany the feeling of tongue movement. Events in a nano-scale of tongue gestures (200-500 msec.) co-occur with pico-scale control of the tip (roughly, 50 to 250 msec.). As Gahrn-Andersen emphasises, such movements reduce to neither physiology or embodiment because, in perceiving as, what matters is *how it seems* or, thus, "human specific reliance of the virtual and the non-local" (in press: ref). One may sense chicken as one speaks and eats –or, more likely, not. Existential meaning and felt-involvement, nonetheless, animate public displays of a body and/or voice. These emerge as intercorporeal gestures, orchestrated actions, and accommodatory action. Crucially, existential meaning makes the codes of Tetris and Morse amenable to control that draws on felt-involvement.

While all computer games use coding, Kirsh and Maglio's (1994) seminal work on Tetris offers an empirical challenge to computational models of mind. I return to this later. Crucially, the software requires a player to anticipate, react and respond to unfolding situations. In terms introduced above, existential meaning shapes events at an interface as shapes or zoids emerge. Using the feeling of what happens, a player uses manual control to position them and build a wall. In so doing, she uses sideways shifts or, in other cases, rotations to avoid gaps *before* the next zoid appears. Given time-pressure, the screen serves as a physical resource that demands dexterity, thinking, and looking to *see* or *feel* what can be done. Felt-involvement binds existential meaning to what a player does (and is likely to do). By contrast Morse signaling emerged in the nineteenth century and, even recently, was used in military settings. Morse specifies correspondence rules between alphabetic characters and dibs/dabs. While sometimes ascribed to "rules known to a brain", it will be emphasized below that transmitting a signal is far from being automatic. Morse operations thus contrast with silently reciting, say, 7x1=7; 7x2=14; 7x3=21; 7x4=28 etc. As the video evidence of §3.3 shows, a radio operator is an active participant in wide coding. The system unites apparatus and adaptor as both draw on the CNS as part of the body. Having examined the case, the logic is extended to code-like systems where digital mappings are replaced by printed inscriptions. Hypothetically, it may apply to vocal/visible expression whose arbitrary nature qualifies multi-modal expressions as cultural mini-codes.

3.2 Thinking, Turing and computation

In Morse and Tetris people act to link felt-involvement with translated code. In the case of sending a signal, one draws on existential meaning in enabling the code to be transmitted and, in the case of Tetris, one works a keyboard in ways that actualize the code. Far from being mindless, the coordination can be compared with calculating or enquiring of a neighbour's health. It consists in *thinking* that lacks an 'inner' surrogate such as that of imagining the 7x table. In Tetris or in sending in Morse, intelligence occurs without rehearsal: such cases fit what was once a revolutionary view of human cognition. For Alan Turing, *thinking* has a public face

[3] For Gahrn-Andersen (in press), existential meaning arises as human-specific phenomena "connect organisms and environments in ways that are not determined by biological and/or physiological make-up" and, thus, open up "virtual meaning-potential that changes from person to person (Gahrn-Andersen, in press: page).

and is literally extended. In tracking views based on thinking about how use of pen and paper transforms our powers, Wells (2006) presents *On computable numbers* as both specifying a universal Turing machine and a view of the human agent (Turing, 1937). Wells rehearses Turing's argument as follows:

- He modelled a *human computer* – someone who works by making calculations with pen and paper. This enabled him to pursue a definition of computable numbers while relating calculation to psychology and, specifically, how constraints affect being a person.
- He defined computable numbers as numbers that, in principle, can be rewritten by a machine.
- Computation is thus defined by human constraints that enable us to identify a subset of real or computable numbers (independently of embodied interaction).

In sketching a universal machine, Turing formalized what can be done by a paper and pen calculation. The results enact a cognitive process where, as Wells phrases it, "structure in the environment and in the organism are equally important" (Wells, 2006: 10). The cognitive process arises in performing calculations under constraints or "the interaction between neural machinery and external symbols" (Wells, 2006: 16). It is managed, as argued below, in multi-scalar interaction between brain, body and world. Remarkably, even though no digital computer had even been imagined, Turing intimated that future devices would transform our view of thinking (Turing, 1950). In this context, the facts are important, above all, because they show that Turing's work was at odds with the received view of codes: he made no appeal to hardware and saw the universal machine as extending (not modelling) human intelligence. In its historical context, this was not understood as Turing's work was subsumed into Von Neumann architectures. Instead, his revolutionary view was neutered as an ungrounded computational model of mind.

Technoscience connected Turing style computation with Craik's (1967) view that models can have *objective validity* –they can be used, he points out, to build (literal) bridges. Yet, far from looking beyond the body (as Turing had suggested), Craik's models were ascribed to a neural *locus*. As these views became conflated, brains were imagined as forming mental maps (or systems) that used computable numbers or codes. The picture led to computational models of mind which, since the 1990s, have increasingly been replaced by models that allow embodiment. Such models build, on the one hand, on robotics and cognition in the wild (Hutchins, 1995) and, on the other, on neuroscience and human biology (see, Shapiro, 2010). Yet, as noted, code biology points to a different approach. Lived functionality is neither semantic nor propositional because syntheses draw on, not information processing, but a bodily apparatus (wetware). This uses (self-fabricating) adaptor systems whose outputs stand-in for interpretation. Rather as Turing had originally suggested, I treat this view as allowing cognition to extend beyond the body people use cultural resources (e.g. codes and programs). Given wide realization, adaptor-like systems can draw on/shape skilled modes of action that can be integrated with the use objectively valid formulations (based on alphanumeric and idiographic systems) to build bridges of concrete and steel.

Even if extending thinking beyond the body is revolutionary, Turing was reliant on formalisms. While not concerned with brains, he separated human physical and intellectual capacities (Turing 1950). In pursuing computable numbers, he asked how calculators or coding devices can transform the idea of *thinking*. The move is, I submit, remarkably prescient. Today, moreover, the view connects with new approaches to how living bodies *actualize* thinking (both as wetware and as living persons). As shown below, the artificial codes of our culture can prompt living bodies to use felt involvement in pre-constructed ways of acting. Whereas, culture lay outside the domain of cognition in Turing's time, there is now acceptance that culture is central to thinking, language and action (even if language-systems are said to have a 'biological' counterpart).[4] Given this consensus, I build on a neutral formulation. In Robert Wilson's (2004) terms, I sketch how 'wide cognitive systems' are *realized*. In restricting cognition to how living beings and their extensions realize events at particular instants, one can pursue culture as part of cognitive process. This arises in how living systems bear

[4] The issue echoes the debate about representationalism; for the former, culture is often seen in terms of material structures or memes; for the latter, it is ascribed to special kinds of affordances of the emergence of a special kind of participatory sense-making.

properties and can be clarified by teasing apart modes of *realization*. Whether properties are features, characteristics or traits, they depend on how a living being or bearer, self-sustains and adapts to events in a particular environment.

An entity or bearer can realise its own properties: for example, being a parrot is realized by the characteristics of the bird itself.[5] Parrot properties depend on 'narrow realization' or, in this case, the living system's own self-sustaining powers. Like being a parrot, organic coding occurs within a cell membrane (viz. an entity) and is, in this sense, narrow. Wilson, however, emphasises self-sustaining systems that extend beyond bodily bounds. Echoing earlier work, cases like calculating with pen and paper draw on *wide realization*. In calculation, this is non-trivial: as a *wide* and public process, the results can be checked and, in time, used to self-fabricate calculating skills (or, indeed, in developing a model of a universal Turing machine). Crucially, wide systems allow realization to depend on non-local factors (and human experience): they link parts, a process and organizing with multi-scalar powers. Wilson illustrates with the case of a predator whose traits and characteristics can only be realized together with those of (for example) its prey (see, Fig 2 below). Wilson's focus is on how, in a changing world, a predator's properties are realized: wide systems connect up evolution, learning, migration etc. To be a predator, or a human computer, is to draw on multi-scalar temporality and shifting modes of control as action shifts between using what one knows and, at other times, using bodily skills to deal with contingencies. In living systems, narrow and wide realization co-occur both successively and, of course, in a given moment.

As exemplified by navigation (Hutchins, 1995), practical problem solving (Valleé-Tourangeau, 2013) and linguistic embodiment (Cowley, 2014), as humans act and perceive, they bind historical resources into lived experience. Cultural modes of wide realization open up new forms of multi-scalar activity and, of course, new ways of organizing the life world (e.g. by using automated systems in a cockpit as important supports for activities involved in flying a plane). A focus on how wide realization integrates temporalities is consonant with Turing's approach. In turning to wide systems, we are therefore concerned with how organized and organising components permit flexibility. Wide systems rely on limited lee-way that grounds discrimination, enskillment, learning and, where embedded in practices, diversification between groups and, thus, cultures. The value of flexibility thus lies in how one can adapt to future states of affairs. Not only do predators integrate skilled use of bodily resources with external cues but, as they do so, they learn about the environment, potential prey and the habits of its pack. In human problem solving one can learn from mistakes and, at times, develop ways of reaching insight. People connect external resources with working memory, expectation, perception and action. While wide realization varies, Figure 2 sketches a predator system (2a); and how computer-derived data can serve a human user (2b).

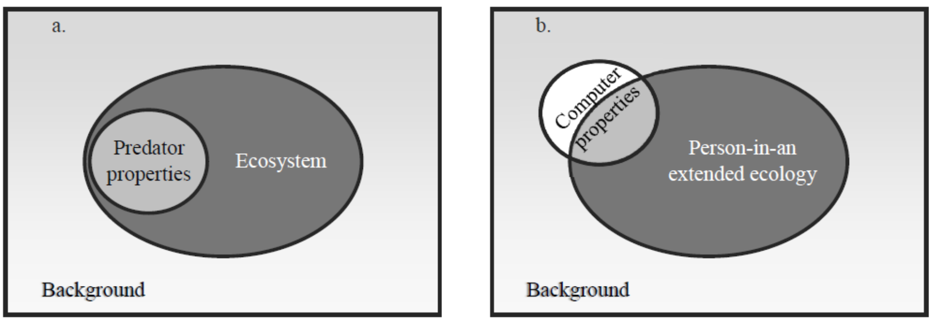

Fig 2. Two wide systems (adapted from Wilson, 2004).

[5] A referee raises an ontological query. While a valid question, for our purposes, 'wide-realization' allows a person to operate *within* a game of Tetris or as *part of* a naval team: activity links up a physical world, cultural resources, felt-involvement and bodily activity (i.e. what happens is not entirely bodily or mental).

Predators inhabit an eco-system where they can draw on how a pack learns from a history of past encounters. However, they lack any way of reaching out for 'hidden' information. Humans, by contrast, use material, institutional and linguistic resources to reach into the unknown. In playing Tetris, as one engages with the interface (or translated codes), one notices many kinds of pattern. In dealing with multi-scalar change, there is no need to know the code; rather, one uses traits and features at the interface to develop skills. Aspects of the perceived world prompt a person to bring the past into the present by drawing on felt-involvement in the game. Conversely, such devices also change ways of managing pasts and futures: for example, people now use smartphones to share photographs or influence attitudes. Indeed, sense-saturated experience connects seamlessly with the deliverances of technology. Given human kinds of cognitive control, we find many other differences. Human can mesh the automatic with the deliberate: they learn from output without using the software's potential. In Figure (2b), therefore, coding uses indirect effects on a person's experience. Indeed, for such reasons, wide systems are changing our view of cognitive processes. In what follows, I bring the OC model to the study of wide systems.

4.0 Artificial coding and the organic code model

In Tetris and Morse physical coding occurs within an artificial device (a computer or transmission system). In applying the OC model, therefore, I focus on events at the Tetris interface and how a transmission key is used in Morse. Felt-involvement is crucial in that, without it, there would be little incentive to play Tetris or send in Morse. In fact, as humans participate in wide systems, like the blind-man with his stick, they draw on existential meanings to engage feelingfully with the world. The observation parallels how adaptors co-evolve by bringing new functions to translated DNA. In turning to how the interface (in Tetris) or piece of script (in Morse) contribute to what happens, I ask the following:

- What syntheses, if any, are observed to occur?
- If so, can we distinguish between apparatus and adaptor?
- To what extent can we know which parts constitute the apparatus and which function as an adaptor?

Responses can be automatic and synthetic (in this context, I leave aside intermediate cases). In automatisms, action is predictable and amenable to description in terms of goals (and rules). By contrast, synthetic response arises from a coding intermediary's non-mechanistic and (non-interpretative) action. Later, I explore implications for expertise, experiential meaning and, generally, multi-scalar temporality. Section §3.1 traces moves in Tetris to an apparatus that *includes* an adaptor. In §3.2, I use code enabling to pursue Morse operators use artificial codes to fine-tune as apparatuses who also draw on adaptor (like) skills. The case thus throws light on the dual nature of human functionality.

4.1 Wide coding in Tetris

The Tetris interface translates a code into the appearance of moving zoids on a changing screen. The code is *actualized* by playing the game. A player uses felt-involvement while manipulating controls to deal with an interface: she relies on *appearances* or what is seen (in what can be seen). Indeed, without existential meaning (and seeing as), Tetris would be (at best) a peculiar intellectual puzzle. In fact, people experience the game as a bodily invitation to explore the feeling of what happens. As a result, the OC model opens up various possibilities. We can ask:

1. Does control by an apparatus use felt-involvement in wide coding?
2. Are physical links with translations of the code integrated with a wider apparatus by virtue of their temporary and yet sustained nature?
3. Can an apparatus self-sustain felt involvement by using the results (automatic or synthetic)?
4. Does involvement enable activity to reach beyond reactions and conditioning and/or habit taking).

The first two questions demand affirmative answers: as apparatuses, players concert perception, and felt involvement while engaging with the interface and, thus, the translated code. They see what is happening, move pieces, score points and live feelings through clicking and other movements. They are involved in play and, as with protein synthesis, reliant on temporary but sustained contacts. As a result, the code is an external memory (or an invoker of past experience) that prompts them to develop various skills.

Since individual differences occur and contribute to expertise, the process is not wholly automatic. One can ask, therefore, if moves reduce to habit or, as Maglio et al. (2008) suggest, if they have the efficiency, optimality and fluent performance of expertise (e.g. Logan & Klapp, 1991; Logan, 1992; Newell and Rosenbloom, 1981). One can also ask how players develop valuable new moves. Further, grounds for separating the apparatus from the adaptor are likely to occur only where results enrich felt-involvement. Whereas stimulus-response and learning call for actions that can be modelled by a central executive, many moves in Tetris are not mechanistic. Famously, Kirsh and Maglio show that they defy the Sense-Model-Plan-Act (SMPA) that dominated classic cognitive science. In their early work, attention fell on *perceptive actions* or control of gaze, attention and action (Kirsh and Magio, 1992). Later, this was rethought around the *epistemic actions* (Kirsh and Maglio, 1994) that are more fully discussed below.

The SMPA model treats the brain as/like a processor that uses input (Sensing) which produces output (Acting). On such a view Tetris moves must be reactive and/or planned. In the planned case, a player links a sense (S) with what, given experience, can be modelled (M). In Tetris, (M) specifies moves for building the wall of zoids: to improve performance planning is required and, thus, a central executive that links models to plans (P). In a sophisticated case, memory store could integrate previous outcomes with results to give rise to plans (and, perhaps, evaluations). Finally, the central system would control how the implementation shapes output that is also action. The model uses the von Neumann architecture and is extremely powerful. To show its validity, Kirsh and Maglio used the SMPA model to write a RoboTetris program that played the game. Strikingly, RoboTetris has no equivalent to an adaptor but, rather, is designed such that two software systems co-function as a composite (or modular) apparatus.

Tetris is designed such that any move does (or does not) bring a piece closer to its final position (Kirsh and Maglio, 1994: 216). Where they approach this position, these are designated *pragmatic actions* and, naturally enough, these moves are precisely the ones selected by RoboTetris. Using SMPA, the program uses pragmatic actions to optimize and, by so doing, outperform all human players. Of course, living Tetris players also make use pragmatic actions: most of us can become moderately good at Tetris. Crucially, however, humans also make *other* moves. In 1994, Kirsh and Maglio specified these as *epistemic actions* which were said to uncover information that was either hidden or hard to compute. Although, they have no counterpart in RoboTetris, human players use them extensively –and, often, effectively. In OC terms, Tetris players link repetition and success with learning from the *feel of the game*. In time, they use epistemic actions to improve their scores: drawing on felt-involvement, they gain skills and develop valued moves. So, do they count as syntheses? While initially calling them perceptive actions (Kirsh and Maglio, 1992), the description was abandoned. Perhaps this was a response to a possible objection that they failed to clarify how a player knows how or when to control gaze, action and attention. Instead, Kirsh and Maglio (1994) re-baptised them as epistemic actions that include “translations” and “rotations”. By implying that players act to know, they may have felt they had parried objections. I return to this question in relation to two classes of such moves:

- Early rotations for discovery
- Rotation to save effort by creating an orientation-independent representation

Zoids emerge at a rate of one square for every 150 milliseconds (ms). A three-part figure takes 450ms to emerge and, yet, players often act to rotate an *emerging* piece. Since they lack the sensory information to plan, they anticipate in a nano scale. In Damasio’s (1999) terms, they notice and respond by using the feeling of what happens. However, not only do players fail to report such moves but, as Kirsh and Maglio (1994) show, their moves can show exquisite sensitivity to the program. For example, they may show a significant tendency to rotate a 'just visible' piece in column 4 rather than an identical piece in column 5. Appeal to 'noticing' and 'responding' is thus wholly metaphorical: for Kirsh and Maglio, the players do not "bother to compute an orientation-independent representation of the zoid" (1994: 530). Rather*,* they use rotations to save effort by *seeing* various orientations which is, they note, "computationally less demanding than mentally rotating". Fair enough. But, if this is an *action* (as the label says), we can still ask how they know *when* to act this way. Whereas now implying that they act in order to know (as if they know that they don't know), there is a simpler alternative. The OC model can open up how existential meaning affects how they engage as part of a wide system. In this setting, players can be prompted by, not what they know that they don't know, but by how an interface sets off the feeling of what happens. Where not prompted to pragmatic moves, they can rely on *dynamics.* Their epistemic power arises from, not central control, but the expert's familiarity and felt-involvement with the game. While also learning to act pragmatically, much depends on moves (not actions) that, as in the OC model, use the code's wriggle room (and results that set off contingency based learning). Later, Maglio et al. (2008) sought to clarify the process by suggesting that the *brain's representation creating rotations* capture, not zoids as such, but 'multiple perspective representations.' Orientation independent representations, on this view, arise from identifying zoids by linking perceptual chunks to the workings of an iconic buffer (534). This is compatible with the (repeated) use of lee-way and the gradual identification of suitable perspectives –and viable ways of action. However, Maglio also masks how one *knows* when to create a representation. It is thus more parsimonious to claim that, as part of a wide coding apparatus, humans use bodies, and bodily parts, as (or like) adaptors. Given intermittent and yet sustained contact with an interface, felt-involvement bridges between worlds (i.e. their sense of the game and the device) by prompting moves (that come to draw on multiple perspectives). Rather than draw on central control, they *act epistemically as parts of a wide system*.

Players also rotate pieces that can already be seen on the screen. Again, the problem is how and when a strategy is chosen. Kirsh and Maglio (1994) propose that brains avoid 'inner' mental rotations by using a principle of economy. In folk terms, they check or monitor what can be seen. In RoboTetris, of course, there is no seeing – no existential meaning. Humans, by contrast, can juggle seeing with gazing or what, in early work, Kirsh and Maglio (1992) had called *attending*. They use separable processes to look at a piece, evaluate it, and assess its action potential (perhaps using representations). This links the nano- and pico- (as defined above) in adaptor-like use of multi-scalar temporal cognition. It too seems synthetic. Of course, while merely showing that Tetris players do not optimize, this too suggests that their moves enact or mimic adaptor functions. They use the program's lee-way in coming to perform more effectively.

Kirsh and Maglio did not pursue the view that parties 'use the world to improve cognition.' Nor has it proved possible to generalise 'epistemic action'. Furthermore, there is a compelling reason to trace the moves to expertise with wide system dynamics. As Kirsh and Maglio point out, "every action in this game has the effect of bringing a piece either closer to its final position or farther from its final position, so it is easy to distinguish between those that have a pragmatic function and those that do not" (1994: 516). In short, an 'epistemic action' uses Tetris architecture such that it *lacks* pragmatic function. Far from being a type of action, the label identifies non-pragmatic dynamics built on felt involvement. Accordingly, I regard skilled epistemic activity as intrinsic to a wider system. Strikingly, this resonates with the hunch that perceptual process links actions with 'cognition' (Kirsh and Maglio, 1992). Further, while not stressing multi-scalarity or dynamics, Kirsh came to describe the interface in terms of *interactivity* (Kirsh, 1997). However, he saw this as – not wide system activity – but as reducing to function. External representations were seen as a locus where expectations ('projections') set off moves and visible results (Kirsh, 2010). After that, he turned to how dancers learn from linking dynamics to representational marking (Kirsh, 2011). Paul Maglio, by contrast, turned to the brain's 'self-priming' (acting to evoke task relevant contextual links) and shows experimentally, first, that Tetris experts use multiple zoid views more than novices, and, second, that they make better use of timing (Maglio et al., 2008). While important, this leaves out *when* people make multiple views or *how* timing is controlled. The OC model suggests that these may be the wrong questions. It seems that players link multi-scalar temporalities to syntheses by using the *feeling of seeing*. Body parts use activity – intermittent and sustained clicks – to link experience with action: wide coding re-organises understanding. In terms of the OC model, there are two modes of control. While pragmatic actions use a whole-body apparatus ('know-how'), Tetris players also link body dynamics and felt-involvement with an interface. While function matters, one must also ask how wide coding systems allow adaptor-like functions to derive from a history of achieving results based on epistemic dynamics.

4.2 Human adaptors: the case of Morse

Tetris players actualize codes through intermittent and sustained contact with a physical device. They use felt-involvement to link central control and epistemic dynamics. They make expert use of contingencies that become familiar in a wide coding system that leaves lee-way for bodily action. In so doing, they use a changing sense of existential meaning to act as (or like) adaptors. Tetris thus attests to how epistemic dynamics serve in gaining expertise (or know-how bearing on the gain). However, if one is to clarify how body parts take on adaptor-like functions, much can be gained by considering a wide system whose functionality uses static code. I use a 1945 US Navy video that glamourizes the role of a Morse radio operator.[6] Whereas a Tetris player enables code by using a program, a radio operator use action to *actualize* the code.

In the video, an operator receives a slip of paper that shows the script: X RAY BT 14L5. Having looked at the paper, he encodes a signal which, once decoded, allows a naval task force to alter its course. By actualizing the message, the code intermediary's body affects the fleet's actions. The rewards are indirect and, in this case, draw on military training. Emphasizing motivation, the focus falls on an operator's 'fighting weapon' or, simply, correct use of a transmission key (See figure 3).

Figure 3

The key is part of a translation process that, once again, establishes brief and sustained contact between two independent worlds (i.e. of operator and the fleet's controllers). An operator is expected to grasp its workings and check both physical contacts and the tension spring: if well-maintained, signals will be 'crisp and understandable'. She also anticipates and monitors performance quality by using acoustic feedback from her signals. While not voiced in the video, operators notice if something is amiss—signals evoke expectations of what should be heard. Like playing Tetris, sending in Morse is multi-scalar and juggles working memory, action and monitoring. On the one hand, it depends on rule-following by a whole person. On the other, as with Tetris, it uses the epistemic dynamics of a wide system that includes a skilled operator. Message sending is fine control that, as Maglio et al. (2008) propose, uses self-priming based on the sound of one's signalling. The timing can be illustrated by a signal of: WE DO. (See Figure 4)

[6] https://www.youtube.com/watch?v=XjupJslRj5E

Figure 4

Using the by-hearted knowledge of the apparatus, the operator thus resemiotises the characters W, E, D, O -he takes letter-like units and transforms them into carefully controlled movements. The lengths of dibs and dabs (so 'W' is dib, space, da, space da and is followed by a double space before the dib that corresponds to 'E') depend on making use of felt-involvement to specify a goal. As absolute lengths are not given, it is essential that the activity be intermittent, sustained and controlled. As in Tetris, individual differences arise as coding links brain, the transmission key, auditory feedback and the operator's body. Further, since control of body rhythm occurs in a wide system, it needs to be coupled with the doings of the unified apparatus. The rendering of dibs and dabs unite the operator's pragmatic action with of body parts that play an adaptor role while triggering existential meaning. As the commentator reassuringly says, "you soon develop a second sense of correct timing" that enables you "to send clear readable code". Only felt involvement can enable control the transmission key based on monitoring perceived rhythmic feedback. In addition, the narrator stresses the importance of a posture that allows you to 'play your arm comfortably', keep your feet underneath the chair and 'sit erect'. As an adaptor, the Morse operator uses body parts that link up brain, eyes, ears, arms, wrists and tips of the fingers (see, Figure 5):

Figure 5

Sending in Morse depends on what, in Tetris, are called pragmatic actions: it uses centrally controlled know-how (i.e. being able to use the rules). It does not reduce to implementation because the operator needs body parts to *concentrate* on sending – even in rough weather. To avoid the 'glass arm' one needs a special way of exerting pressure with the forefinger. In sending Morse, as in Tetris, much depends on epistemic dynamics. While offering little lee-way, performance is not mechanistic but, rather, based on felt involvement that uses tactile and auditory dynamics. The operator uses cognitive powers to monitor his/her actions: on-going control is essential to effective signalling. Far from working as an apparatus (i.e. in line with the received view), the radio operator actualizes control over body parts. In this case – and in contrast to Tetris – the operator's adaptor-like function can only derive from felt-involvement at an interface that uses wide-system dynamics. Sending extends expertise and draws, to a large extent, on self-fabricated skills. In spite of parallels between Morse and Tetris, this is a striking difference. Whereas the code enabling of Tetris draws on lee-way and filling in (gaining skills), the code actualizing of Morse leaves little wriggle room for how one transforms X RAY BT 14L5 into dibs and dabs. Rather, the operator-as-adaptor is bound to draw on multi-scalar activity to resemiotize the marks by managing his or her patterned tapping: systems of body parts (see Figure 5) co-manage epistemic dynamics.

4.3 Pragmatics, adaptors and languaging

In focusing on whether rules are correctly implemented, the received model of codes can say little about cases such as Tetris or signaling in Morse. By contrast, the OC model clarifies how human body-apparatuses bind the pragmatic with the epistemic. Thus, while the pragmatic is brain-based, the epistemic uses felt-involvement and wide system dynamics. The resulting view of human agency fits how Turing pursued calculation as extending body-based understanding. However, I have stressed that it applies in different ways. In code *enabling* such as Tetris, the total system links a mode of action with changing code output (an interface that resembles translated DNA). As with many perceptual systems, intermittent and sustained contact has the signature of adaptor mechanisms that shape synthesis. The OC model is thus a richer model than a received code view. Further, in the Morse case of code *actualization*, the operator acts as (or like) an adaptor by using a transmission key to manage rhythms of sustained/intermittent contact. The richness of the case supports the view that coding-with-adaptors is one of nature's simplex tricks. In illustration of the claim, Table 1 uses the OC model to compare the three cases.

	Protein system	**Tetris**	**Morse**
Total system	cellular apparatus (narrow)	Player, Tetris software, hardware, interface (wide)	Naval setting, Morse transmission system, radio man (wide)
Independent worlds	Translated DNA-tRNA	Player-interface of device	Signaller-transmission key
Bridging mode	Intermittent but sustained content (the signature of an adaptor)		
Adaptor	tRNA (plus aRNA)	Epistemic dynamics in wide system	Monitored body control/movement.
Change in time	Protein systems evolve	Skills in pragmatic action and epistemic routines	Increased rule consistent fluency and use of embodiment

Table 1: Commonalities across the 3 systems

The OC model links coding (in epigenesis/metabolism) with copying DNA (cross-generationally). Since artificial codes do not self-fabricate, it is striking that another duality appears. Thus, in the code enabling of Tetris, players make pragmatic and epistemic moves. Whereas pragmatic know-how can be viewed as goal directed, epistemic activity uses wide system dynamics (i.e. the program). As Turing foresaw, the body grounds pragmatic action (as exemplified by calculation). However, the OC model rethinks the epistemic: it turns to, not functions, but a system of distributed control. In dealing with the wider system –through both enabling and actualizing -- felt-involvement at an interface is action by a coding intermediary. By linking experience and felt-involvement, dynamics link existential meaning, a program's lee-way and experience-based moves. The contrast with the pragmatic lies in – not a kind of 'action' – but how the *feel* of the interface enables one to manage its dynamics. In OC terms, the synthetic draws on and shapes what becomes player-specific activity (and beliefs). Our view of Tetris gains from approaching how players function as (or like) adaptors. To grasp how human systems come to sustain epistemic activity, however, one needs to consider how codes are actualized as in the case of Morse.

Living systems evolved and, for this reason, do not need external actualizers (or operators). Yet, in artificial systems, even static codes must enable humans to gain adaptor-like bodily control. Indeed, a body-apparatus that uses a transmission key exhibits the same duality within a wide-system. While the pragmatic uses rules that are known by heart (based on a learning history) these need the support of epistemic activity. Not only does this too use intermittent by sustained contact, but epistemic dynamics rely on how a wider system orchestrates the self-managing of bodily dynamics. In the radio operator, adaptor like parts sustain *responsibility* as s/he controls posture, moving, looking and listening. Just as with Tetris, felt-involvement co-functions with existential meaning in a wide system (including hearing one's own signals). Once again, duality of action binds two modes of motivation –more goal directed action occurs alongside the use of wide system dynamics as a coding intermediary.

Protein synthesis, the code enabling of Tetris and the code actualizing of Morse can all be described in terms of coding-with-adaptors. As in deep learning, outputs use multiple inputs and, thus, re-use of lived experience (and brains). Like (or as) adaptors, parts of persons use translated code such that, over time, the bodily apparatus develops differentiated skills. Since, there is no easy way to identify nature's simplex tricks, the case builds on parallels with organic codes. However, even as a comparative tool, the OC model redraws the distinction between actions that are (and are not) pragmatic. Instead of invoking epistemic *function* or underlying systems, wide-systems are seen to shape distributed mechanisms that control epistemic activity. Implicitly, *learning* links definite outcomes with skills based in familiar use of felt-involvement and existential meaning. While some action becomes apparatus-centred, wide systems enable moving, feeling, perceiving bodies to learn from dynamic epistemic activity.

Whereas organic codes evolved, their artificial counterparts rely on human beings. Using a transmission key, a person actualizes Morse signals by managing bodily activity. As parts of the body act as (or like) an adaptor-system, a person becomes skilled. Using the signature move of intermittent but sustained action, an operator learns to resemiotise an arbitrary string ("2 X RAY BT 14L5") as rhythmically timed tapping. Unsurprisingly, there are parallels with acts of writing. For example, typing, *"the cat sat on the carpet"* can be seen as a goal directed or pragmatic action. In resemiotizing thus, the writer links goal-directed function ('intending' to write *just that*) with what can be regarded as acting as (or like) an adaptor. Far from having to 'encode' a pre-extant script (or 'idea'), an act of writing can use a wide system's epistemic dynamics. In acting as (or like) an adaptor by composing a sentence about a feline, I draw on previous acts of writing to link existential meaning (and felt involvement) with anticipative action. Just as in Morse signalling, the actualization occurs under the constraints of 'by-hearted' spelling, punctuation and other rules that set up correspondences between independent worlds. Yet, it uses epistemic dynamics: as on-going text-making it binds my personal 'world' with systems far beyond the screen or page. Like a Morse operator, I link bodily control, observing, monitoring and –above all –a history of multi-scalar filling-in or using wriggle room to explore the possible. Accordingly, acts of writing often have synthetic effects. Even if appeal to adaptors is metaphorical, the OC model allows the 'creativity' of writing to use non-mechanistic ways of performing (e.g. based on an alphabet code). The focus on resemiotizing contrasts with received views of codes that appel to 'language'. In such a case writing about a sedentary cat is ascribed to an priori representation (or 'idea') like "the cat sat on the mat". Not only do acts of writing become a quasi-mechanistic process of language production (based on a hypothetical language faculty) but crucial factors are blatantly ignored. The received view of code omits the body, the epistemic and, in this case, why I chose *not* to write MAT. Indeed, the view reduces resemiotization to language-use that, bizarrely, is taken to be separable from persons.

Our many ways of reading can be seen in terms of the OC model. Rather as with Tetris zoids, one engages with aggregated symbolizations (e.g. *these ones*) on a page/screen. A reader uses them to act, not by decoding, but by filling in hints (e.g. seeing 'these ones') that trigger familiar cognitive resources. As in playing Tetris, reading uses intermittent and sustained contact with appearances (e.g. how 'these ones' *seems*). By hypothesis, a reader acts as a code intermediary who used epistemic dynamics (saccading). She synthesises what she is able and willing to make of seeing *these ones* (she grants sense to aggregated symbolizations). Drawing on a history of similar appearances (e.g. *those ones*), pragmatic moves based on knowledge/belief bind with motivated attending as part of a wider system (e.g. as a student with an exam). In terms of the OC model, dynamics prompt her whole-body apparatus to syntheses based on knowledge *cum* beliefs (she links her own history with cultural infrastructure). In rethinking reading as (like) embodied adaptor-and-apparatus activity, one challenges views that trace reading to linguistic 'knowledge'. On a received view of codes, aggregated symbolizations (i.e. use of spellings, punctuation, grammar etc.) are associated with comething called *language.* Implausibly, this is said, first, to be 'known' and, second, it is assumed that the knowledge serves to identify the meaning of a word, phrase or text (or, at very least its linguistic aspect). Third, the is results are allegedly used in constructing a larger model (discourse processing). But the view falls at the first hurdle. There is no 'meaning' in '*these ones*'! And not just because the phrase is indexical. Even the 'meaning' of *cat* is inseparable from circumstances. For a human reader, however, this is not a problem. Given epistemic dynamics, she can readily grasp 'these ones' as a symbolization on each of six appearance in this paragraph (as well as in other texts). In reading symbolisations like *these ones (*or *cat),* we rely on felt involvement that shapes expert performance in a familiar reading game.

Since literacy practices use code-like alphabets, idiographic and number systems, the OC model traces the skills to bodies, filling in, synthesizing and, importantly, resemiotization. Much depends on bodily systems that self-fabricate to enable pragmatic modes of action. It seems that epistemic dynamics may be crucial in attuning knowing apparatuses and their adaptor (like) skills. Further, since many species act in ways that appear goal directed, as in enactive-ecological views of cognition, this allows knowing to be traced to a history of actively engaging with actual environments. However, the OC model hints at what such models leave aside. Appeal to sense-making, structural coupling, affordances etc. leave out two modes of acting. In the first place, they omit resemiotizing or how humans use felt-involvement in wide systems in ways of acting/believing that use repeating and varying themes: they underplay how codes serve in actualizing. Second, they leave aside how symbolisations (alphabetic, numeric and idiographic codes) enable whole bodies to learn from engaging with wide system dynamics. They leave out how, like Tetris players, people learn effective ways of drawing on codes (and other highly predictable aspects of the physical world). The claims suggest a hypothesis. Rather as the modern genetic code co-evolved with a changing protein apparatus, adaptor-like human functions may have evolved with skills in languaging.

6.0 Concluding remarks

Rather than focus on how formal sequences are used by genes, brains or language, I have argued that the OC model reveals one of nature's simplex tricks –coding-with-adaptors. Using a parallel with protein synthesis, I compare its workings with playing Tetris and sending in Morse. Humans use intermittent but sustained contact to link felt-involvement with experiential meaning. Given the human world's wide systems, a person can become, say, a Tetris player, a radio operator or, indeed, a literate reader. The case is consistent with Alan Turing's view that calculation extends bodily powers. Accordingly, I highlight *wide realization* to stress that human bodies draw on multi-scalar cognition. In these terms, pragmatic Tetris moves are narrow and appear in RoboTetris: they draw on apparatus-like powers and central control. Epistemic Tetris moves are synthetic and, I claim, based in felt dynamics that arise in wide systems. Although entangled, both pragmatic and epistemic activity may derive, in part, from control that is outsources wide systems. The OC model thus suggests that humans (and parts of humans) act as coding intermediaries that use *epistemic dynamics*. The case is made by how a Morse radio operator is apparatus-like in terms of the signals sent (a process that can be automatized). Further, he or she also acts as (or like) an adaptor in performing by linking feedback, existential meaning and modes of action that exhibit qualities such as responsibility and effectiveness. Like Morse operators, Tetris players also become skilled performers.

Where acting is felt to be optimal, the CNS dominates and, at other times, people rely on distributed control. In Tetris, people anticipate, link perceiving to valued information, and monitor dynamics while using long term and working memory. In wide systems centrally managed skills co-function with more fluid control. Connecting pragmatic actions with epistemic activity brings many benefits to a species whose modes of life are deeply historical. Accordingly, the paper briefly glances at implications for literacy. In one sense, using inscriptions is like Morse signalling. As with Turing's view of calculating (see, Pinna, 2017), a reader's symbolisations can be used in transforming future reading and thinking. Syntheses occur as alphabetic and idiographic systems mediate what-can-be-seen with *imagining* the flow of voice dynamics. The parallels st up a strong hypothesis. As in Tetris, languaging may link existential and collective meaning with repeated multi-modal actions *or mini-codes.* Indeed, these might be necessary to language in that, they would allow arbitrary rules to set up correspondences between independent worlds. Further, by attuning, people would gain by using wide systems to act as rule-following participants. In this is so, embodying and monitoring expression during language games would prompt bodies to self-fabricate adaptor-like skills. Language may extend ways of generating syntheses through multi-modal actions/activity. For agents who acting as or like adaptors, syntheses have uses that, in time, can become part of a personal or cultural repertoire. If they ground repeatable expression (gestures and physical wordings), they open the way to using resemiotization in the invention of writing systems and codes. With time, histories and symbolizations groups can learn to shape 'claims' based on calculations, propositions, formulae or symbolizations. As Craik saw, in certain contexts, these can attain objective validity (or not). On the OC model, they need, not mental models, but material symbolizations. In Turing's sense, felt involvement with repeatable vocal patterns or perduring symbolisations extends human cognition beyond the body.

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