



Interactivity: Why, What and How?

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ABSTRACT

This article presents interactivity as the crux for much work conducted by members of the Centre for Human Interactivity. Interactivity can be understood in two senses: First, as the ontological substrate of human action. Second, as an approach for studying human-specific phenomena. The article begins by elaborating on the definition of interactivity as ‘sense-saturated coordination that contributes to human action’. In this connection, we clarify the two central notions of ‘sense-saturation’ and ‘coordination’. With the clarification in place, we move on by showing how interactivity can be studied empirically. First, we present Cognitive Event Analysis as a fruitful methodology for coming to terms with the multi-scalarity of human cognition and social interaction; second, we present a multitude of exemplars and case-studies on interactivity on diverse phenomena including human organizing, reading, trace-making, participatory design, social presence, online consultation and psychotherapy. Finally, we address some of the current and future challenges of interactivity-based approaches to human cognition.

KEYWORDS

interactivity, cognition, social interaction, problem-solving, embodiment, multi-scalarity, phenomenology

The limits of my language mean the limits of my world.
(Ludwig Wittgenstein)

Nullius in verba
(motto of the Royal Society, London; “take nobody’s word for it”)

1. Introduction: Why interactivity?

In this contribution to the RASK special issue on the seven research centres at the Department of Language and Communication at the University of Southern Denmark, we will present the concept of *interactivity*, which over the past decade or so has become a crux for much work conducted by members of the Centre for Human Interactivity (CHI). In this short introduction, section 1.1 outlines the general background for why we propose to give such prominence to a term that is not even listed in the Oxford English Dictionary (Simpson & Weiner 1989). Afterwards, we sketch the intellectual background for this term (1.2). Section 2 is dedicated to a conceptual clarification of our use of interactivity as ‘sense-saturated coordination’. Accordingly, the two subsections in Section 2 will in turn address sense-saturation and coordination. Having thus asked *why* interactivity (in Section 1), and *what* is interactivity (in Section 2), Section 3 raises the question *how* to investigate interactivity. True to the multifaceted character of interactivity, we do so by showcasing several short exemplars (in Kuhn’s sense) of how interactivity is investigated. Finally, in section 4, we will point to some of the outstanding questions in the current debates over interactivity.

1.1 The (anti-)disciplinary motivation for interactivity

Contemporary academia depends on an ever-increasing specialization of the endeavour for knowledge, which leads to a widespread division of labour and a departmentalisation of scientific work. For instance, biology was once a field occupied with the study of “life and living matter” (Simpson & Weiner 1989), but since the term’s first use less than 300 years ago, the field of biology has branched into a vast number of specialised (sub-sub)disciplines. For instance, the batrachologist studies amphibians and, thus, a specific branch of herpetology that in turn is but a branch of zoology, one of the major branches of biology. Similarly, in the humanities, the 19th century philologies have long ago been abandoned in favour of the specialised domains of literary studies, cultural studies, history, and linguistics. Even within each of these disciplines, the degree of specialisation makes cross-domain interaction difficult. What, for instance, do the syntactician, the computational linguist, and the interactional sociolinguist share with one another?

In line with how Ferdinand de Saussure (1972) famously argued that linguistics ought to define itself by identifying its unique object of study (*la langue*), there seems to be a tendency to derive the discipline from its object of study, and reciprocally, a tendency for different disciplines to highlight specific features of reality at the expense of others. Each discipline derives its object of study from its disciplinary matrix (again, in a Kuhnian sense), and thus, in Wittgenstein’s words – as quoted in the epigraph of this article – the limits of the specific approach’s disciplinary language limit what one observes within a given field. While this theory-ladenness is arguably a condition in the scholarly investigation of a given topic (Bogen 2017), the disadvantages are obvious: we may well come to rely on epistemic interests and categories that are poorly grounded, irrelevant, or at least just not as commonsensical as hitherto assumed. That is why the scientific endeavour relies on the attitude condensed in the motto of the Royal Society in London: *Nullius in verba* (“take nobody’s word for it”). To explore new aspects of reality, one

needs not change the world, but one may need to change various disciplinary perspectives and assumptions.

The introduction of *interactivity* into the academic parlance on human behaviour is basically an attempt to approach the complexities of how human beings coordinate their behaviour, without taking pre-established disciplinary boundaries for granted. More specifically, as will be elaborated below, the notion of interactivity aspires to transcend the long-held distinction between a cognitive realm and a social realm, where the former focuses on intra-cranial, unobservable processes and the latter on public happenings. As discussed in detail by Steffensen (2011, 2015), such a distinction overestimates the importance of the localisation of a given process: if a process takes place in the brain, it is cognitive; if it takes place in the world, it is social. This distinction presupposes that the boundary of cognition is the human body (or some part of it, for instance the central nervous system), but this assumption has been questioned for the past two decades. Philosophers of mind like Andy Clark (1997, 2008) and cognitive scientists like Ed Hutchins (1995, 2014) and David Kirsh (2005, 2009, 2010) align in arguing that cognitive processes extend beyond the organism and into so-called distributed cognitive systems. Accordingly, if processes between human beings are (also) cognitive, they cease to be exclusively and exhaustively social, in the sense that they can be fully explained through models of social interaction and social normativity. Replacing ‘social interaction’ with the term ‘interactivity’ functions as a reminder that the coordinative processes that human beings engage in can be described differently by sociologists and cognitive scientists inasmuch as they basically approach the same “ontological substrate” (Steffensen 2013: 196). Interactivity can be described as ‘social’ or it can be described as ‘cognitive’, depending on one’s research interests. But acknowledging that these descriptions are perspectives on one and the same reality is crucial (Giere 2010).

The term ‘interactivity’ also serves to undermine the (at times absolutist) distinction between life sciences that are concerned with the world of the living and the humanities that are concerned with products of human sense-making or meaning-making (such as literature, language, and culture). Seeking consilience between the two, scholars of interactivity emphasise that processes of sense-making do not constitute an independent realm that can be investigated in isolation from the world of the living. Expressed as a slogan, the view is: “if sense-making makes sense, it makes sense outside of sense-making!” Processes of sense-making and meaning-making have consequences for human existence in a wider bio-ecology (Cowley 2014), but such consequences are readily ignored by disciplines that have bought into what Steffensen and Harvey (2018: 3-4) term an “Adiabatic Principle of Communication,” where coordinative actions are confined to a realm of communication, without acknowledging their wider ecological implications.

Finally, given its ecological embeddedness, interactivity contrasts with attempts to limit interaction, coordination, or sense-making to a single timescale and a single explanatory framework. Thus, whereas ‘social interaction’ is mainly described on what Enfield (2014) calls an “enchronic timescale” of turn-by-turn sequentiality, interactivity points to how such here-and-now coordination is constrained by dynamics on multiple timescales (Steffensen & Pedersen 2014). This latter point will be elaborated in section 2.1.

1.2 The roots of interactivity

What does it mean to say that something is ‘interactive’? In recent years, the term has been associated with computers, media, and various devices that are said to be ‘interactive’. In a concept explication, Kiouisis has found that “the term implies some degree of receiver feedback and is usually linked to new technologies” (Kiouisis 2002: 357). From our point of view, it is counterintuitive to reserve the term to designate how mechanical devices can be construed in a way that makes its users *feel* like they are interacting with these devices. The same insight is presented in the very article that builds the necessary conceptual bridge from the field of Human-Computer Interaction (HCI) to a generalised concept of interactivity, David Kirsh’s *Interactivity and multimedia interfaces* (1997). Here, Kirsh rightly points out that “there are many different ways we interact with our environments when we make decisions and solve problems, and [...] many, perhaps most, of these ways are not acknowledged in traditional accounts of interactivity” (Kirsh 1997: 94).

A decisive feature of our interactivity-based perspective is that we take a starting point in how “we interact with our environments” as we pursue a given project (whether it is classified in cognitive terms as problem-solving and decision-making, or in everyday terms as reading, texting, or engaging in psychotherapy). An important figure in this pursuit is the cognitive psychologist Frédéric Vallée-Tourangeau, whose work takes us beyond a classical mentalist dogma in that field, namely that cognition amounts to the internal processing of symbolic representations. He does so by showing how the manipulation of external artefacts increases success rates in experiments on decision-making and problem-solving (Vallée-Tourangeau 2013; Vallée-Tourangeau et al. 2015; Vallée-Tourangeau et al. 2016; Vallée-Tourangeau & Vallée-Tourangeau 2014).

Thus, while the *term* is rooted in HCI, interactivity itself lies at the core of all psychological and cognitive approaches that take a starting point in how organisms interact with the environment. A central school in this respect is James J. Gibson’s *ecological psychology* (Gibson 1979), which develops a psychology of perception that considers “an animal’s encounters with its surroundings as the fundamental phenomenon to be explained” (Reed 1996: 184). Although Gibson does not use the term, Kelty-Stephen et al. point out that “interactivity is central to ecological psychology. The Gibsonian view of perception and action holds that the patterns of an organism’s behavior are best understood as the emergent property of the interactions of the organism with its environment” (Kelty-Stephen et al. 2013: 2). To Kelty-Stephen and colleagues, interactivity “involves interactions among factors at many different scales at once” (2013: 5), so that “emergence of novel structures reflects the coordination of dynamics across short timescales with relatively longer timescales” (2013: 6). This “interdependence of events across scales” (ibid.) makes these authors suggest that interactivity is a property of mathematical models, for which reason they pursue interactivity in terms of mathematical modelling of multifractality and cascading. From our perspective, it is important to emphasise that interactivity is a property of reality, not of the model. Accordingly, while non-linear models are important tools for our understanding of interactivity, they hold no elevated or prominent position in the field. In sum, interactivity is a multi-faceted phenomenon showing how individuals and collectives make their way in the world while drawing on sociocultural and other bio-ecological resources.

2. A conceptual clarification: What is interactivity?

Summarising the sections on “why interactivity” in section 1, two key features of the concept are: (1) how human cognition, coordination, and co-action depend on the coordinative dynamics between organisms and their environment, and (2) how these interactive dynamics unfold on multiple timescales at the same time. As argued by Cowley and Steffensen (2015), human interactivity is vastly multi-scalar, that is, human activity is constrained by far more timescales than is the case for any other species’ activities.

The current section aims to clarify these two dimensions – coordination and multi-scalarity – by elaborating on existing definitions of interactivity (Harvey et al. 2016; Steffensen 2013). Our starting point is the definition that interactivity is “sense-saturated coordination that contributes to human action” (Steffensen 2013: 196). In the sections below, we explore how this definition picks up on the above discussion of multi-scalarity in terms of ‘sense-saturation’ (section 2.1) and ‘coordination’ (section 2.2.).

2.1 Sense-saturation

Many species are capable of drawing on significance in their encounters with the world. For instance, blue tits (*Cyanistes caeruleus*) in Great Britain came to develop the habit of opening milk bottles left in doorways (see Cowley 2017). Having acquired the skill of opening bottles, a closed milk bottle came to be an *affordance* for the blue tits (Gibson 1979). Put differently, a closed bottle went from affording nothing whatsoever to becoming a means of access to food for the birds. Hence, closed milk bottles acquired a special kind of significance.

However, although the habit of the blue tits changed the blue tits’ experience (in that milk bottles gained a special kind of significance), their senses were not saturated in the way that characterizes human interactivity. Thus, ‘sense-saturation’ entails that an individual’s sensorial experience is enacted by infusing it with non-local resources (Steffensen 2015; Steffensen & Cowley 2010), that is, “our here-and-now coordination” is saturated by “the not-here and the not-now” (Steffensen 2013).

Such non-local resources come to the fore in the example discussed in Steffensen (2013). Here, two office workers solve a problem related to missing information in their invoice system. They do so by evoking, not how the problem appears to them, but how it appears to an emulated receiver of the invoice. This emulation of an “absent other” is brought forth by changes in the use of deictics, exemplified by one of the workers saying “I cannot pay that,” where “I” refers to the absent invoice receiver.

In contrast to the blue tits, who acquired the skill of opening bottles, first by coincidence and later through repetition, human beings have a vast behavioural flexibility that allow us to explore possibilities that are not restricted by (our own or others’) past and present behaviour. For the birds,

getting at the cream links chance and dispositions (conditioning, skills or an instinct) with material relations that change perception, action and observing within populations. (Gahrn-Andersen & Cowley 2018: 410).

In contrast, human beings have a capacity for harnessing the behaviours, attitudes, and values of other persons, whether they are present or not. When the office worker utters “I cannot pay that” his vocalisation is constrained by population-level patterns of absent others.¹ Thus, he can observe his own behaviour and modify it, not only from his own situated perspective, but also from the perspective of absent others, including entire social groups (organisations, communities, etc.). Non-local resources are irreducible to embodied memory, genetic predispositions, or bodily habituation, though they presuppose all of them. Thus, sense-saturation is not a process in the individual, it is the result of how individuals engage with past and present collectives and use this engagement to pursue their engagement with the world. So, although animal habits and instincts allow for signification, it is different from human sense-saturation, in that habits and instincts can be explained without reference to non-local resources.

Although first and foremost implicating lived human experience, the phenomenon of interactivity is far from restricted to phenomenological description and investigation. Interactivity is also compatible with explanations stemming from naturalism. In other words, the phenomenon of interactivity can be explored by both 1st and 3rd person approaches.

Naturalistically, human sense-saturation has been explored through multiscale phenomena, thus acknowledging how human living unfolds on qualitatively different time scales. As observed by Cowley and Steffensen (2015: 477),

[t]he emergence of irreversible living systems gives rise to complex intermeshing between what happens earlier and later. Surprisingly perhaps, living beings enact many different kinds of temporalities.

It is crucial to consider temporalities when explaining how the saturation of experience is possible. In the case of the blue tits, past interactions of opening milk bottles allowed for the emergence, and continuous upholding, of a special kind of significance. The same holds for humans, but humans are further able to draw actively and flexibly on past events. Put differently, *diachrony* constrains human living and, in so doing, saturates what happens in a given lived moment in that “a historical residue becomes part of individual modes of talk and action” (Cowley & Gahrn-Andersen, 2015: 62). On this view, human beings are “temporal rangers wandering around in a temporal landscape of multiple pasts, presents and futures” (Steffensen & Pedersen 2014: 95). One way of exploring interactivity naturalistically is to adopt the approach proposed by Steffensen and Pedersen (2014). They elaborate the model presented by Uryu et al. (2014) with the purpose of exploring “the complex temporal ranges in human interaction” (Steffensen & Pedersen 2014: 90). In so doing, they consider “the multiple causal frames that simultaneously determine” (ibid.: 91) interactional trajectories and, thus, saturate human coordination. In

1 The populational-level perspective is explored in detail by Steffensen and Harvey (2018). They argue that a tight coupling in the human organism-environment system allows for hyper-flexible behaviour, i.e., behaviour that depends on minute fluctuations (such as the difference between the speech sounds /ɛ/, /æ/, /æ/, and /a/), and that this flexibility allows humans to develop population-typical sensorimotor skills (Steffensen & Harvey 2018: 14).

recognizing that human experience is situated in the here-and-now – but nevertheless affected by different events that precede it – Steffensen and Pedersen introduce a way of coming to terms with the heteroscalarity of human sense-making. Specifically, they argue that phenomena from a multitude of temporal ranges (including ‘the physical universe’, ‘organic life forms’, ‘utterance activity’ and ‘individual awareness’) affect our situated experience and interactional outcomes.² On this view, interactivity thus is a key category as it presupposes the interdependence of biological agency and sociocultural personhood in a physical world.

Non-locality has not only been explored naturalistically in relation to different timescales. This brings us to the phenomenological aspects of interactivity and, more specifically, how experience connects with human specific ways of being in the world. The phenomenological dimension of interactivity has been explored in critical relation to what has been called *Autopoietic Enactivism* (see Cowley & Gahrn-Andersen 2015; Harvey et al. 2016). Proponents of (this branch of) enactivism hold that living systems in general make sense of their surroundings by means of intrinsically derived norms and values – many of which are strictly biological. In other words, living beings – humans included – are strongly autonomous. Although a strongly autonomous biological organization might be well-suited for considering, for instance, the sense-making of frogs (see, Maturana & Varela 1980), it makes little sense to appeal to it when exploring human interactivity. The reason for this is that humans make sense of their surroundings in ways that derived from previous social encounters and that are infused with social significance (Harvey et al. 2016). In other words, individuals draw on *heteronomy*, that is, social norms and values that are not intrinsically derived from the individuals themselves, but rather extrinsically informed (Gahrn-Andersen & Cowley 2017). For example, as Gahrn-Andersen (2019) argues, we have acquired a certain practical understanding of our surroundings that allows us to perceive things as particular kinds of things. Thus, instead of being strictly tied to biological and neurological resources, the experiential horizon of humans is deeply social in that it involves non-localised, heteronomous resources such as conceptual knowledge, social norms and embodied skills.

2.2 Coordination

Having clarified the sense-saturation involved in interactivity, we now move on to discuss the phenomenality of the kind of coordination that is saturated. Importantly, in being human-specific, sense-saturated coordinative dynamics are irreducible to coordination in general (i.e., the coordination generally characteristic of other primates, cells, physical entities or chemical components). As indicated above, sense-saturated coordination pertains specifically to human-environment relations and, as pointed out by Gahrn-Andersen (in press), it emerges as a behavioural potential at a decisive point in the ontogenetic development of the infant. In other words, certain infant-caregiver dynamics – including the early interactions that happen in the uterus (see Gallagher 2011) – do not involve sense-saturated coordination. Thus, sense-saturated coordination does not characterize all human behaviour. It depends on an important developmental shift which occurs during what Trevarthen (1979) calls *secondary intersubjectivity*. At this point in development, infants progress from interacting only with their caregivers to also orienting to

² See Pedersen and Steffensen (2014) for an operationalization of the model in a real-life medical setting.

objects (or, ‘impersonal thirds’). It is this shift, which Tomasello (1999) identifies as “intention reading”, that gives” rise to sense-saturated coordination. But whereas Tomasello places decisive emphasis on the infant’s ability to understand caregivers’ intrinsic intentions and motivations, the interactivity-based perspective emphasises that the infant gradually comes to draw on a population-level perspective. Gahrn-Andersen points to how these changes in coordinative dynamics (in terms of a population-level perspective) give rise to novel experiential and existential dimensions:

The first instantiation of interactivity does not occur in isolation from past interactions with caregivers. Rather, the infant comes to understand past interactions in new ways [so that] the past catalyzes novel modes of coordination [...]. (Gahrn-Andersen in press)

By drawing on past experiences, which then come to function as non-local events and resources, the infant is enabled to engage in modes of coordination that differ qualitatively from his/her past interactions. The reason for this is that the influence of past encounters entails sense-saturation as the child brings supra-individual or collective significance experienced in the past into the present. It is by means of this significance that the child is able to play fetch-games, adhere to social norms and expectations, and, eventually, experience utterings as utterings (cf. Gahrn-Andersen & Cowley 2017). Emerging in child-caregiver-object triads, sense-saturated coordination generalises beyond such triads. For instance, Pedersen and Steffensen (2014) consider how the multitude of different temporal events and, thus, non-localised resources impact on the interaction of healthcare professionals:

A novice doctor’s visual system both depends on local coaction and on non-local events (Steffensen & Cowley 2010), such as the patient’s prior visit at his GP, the doctor’s experiences from medical school, and the sociocultural practice embedded and incarnated in the medial record as a tool and artefact. (Pedersen & Steffensen 2014: 157)

Importantly, sense-saturated coordination needs not be overtly intersubjective as in the examples just mentioned. In fact, as shown by Steffensen and colleagues (2016), even human problem-solving in solitude involves sense-saturated coordination.

3. Methods, cases and exemplars: how do we study interactivity?

Having discussed the *what* and *why* of the concept of interactivity in the previous two sections, the current section discusses *how* we might study interactivity by presenting empirical work currently carried out by members of the Centre for Human Interactivity.

3.1 Interactivity and cognitive events: Cognitive Event Analysis

Having established that interactivity is an ontological premise for human action, we now introduce the ecological and interactivity-based approach named *Cognitive Event Analysis* (CEA) (Steffensen 2013, 2016; Steffensen et al. 2016), which is a qualitative method for analysing instances of enacted temporalities on various timescales. In other words, CEA enables the researcher to investigate sense-saturated coordination, since the method regards inter-bodily dynamics (e.g., prosody, talk, gesture, and movements) as they emerge interdependently within a cognitive ecosystem. Thus, human agency (as well as conditions for human agency) are investigated, as CEA's epistemology reflects both an interest in inter-agentive dynamics as well as an interest in the possibilities and conditions of the cognitive ecosystem. The cognitive-systemic interest is rooted in Hutchins's work on distributed cognition and cognitive anthropology (Hutchins 1995, 2003, 2014), and the analytical interest in interaction is connected to perspectives from the Distributed Language Approach (Cowley 2011; Steffensen 2015; Steffensen et al. 2016), and Goodwin's multimodal approach for studying interactions and cognitive phenomena (Goodwin 2013). Combined, these insights contribute to investigation into, and elicitation of knowledge of how slow-scale, sociocultural organisations influence and are enacted in fast-scale interpersonal dynamics, thus supporting the investigation of multitemporal scales (Pedersen & Steffensen 2014; Simonsen & Steffensen 2019).

In this way, "CEA studies cognitive ecosystems by investigating the system's cognitive trajectory, that is, the dynamical and nonlinear path that the system creates as it achieves a given cognitive result" (Steffensen et al. 2016: 82). Specifically, the researcher works with empirical video-recorded data, as s/he meticulously studies the phase transitions, i.e., potential reorganizations and changes that constitute the dynamic of the cognitive trajectory (e.g., scrutinizing how an error is detected or how a solution is reached). Such changes are characterized as *events*, defined by Chemero as "changes in the layout of affordances of the animal-environment system" (Chemero 2000: 39). Moreover, the particular phase transition that leads the agent to enact change in the organism-environment system is in CEA terminology regarded as an *event pivot* (Steffensen 2013). Thus, when a practitioner diagnoses a patient, the event pivot characterises the particular kind of behaviour that constitutes the doing of "making a diagnosis." In this way, the cognitive event can be understood as an achievement of the agent: "It is the result of the agent's behaviour (whether it matches the agent's intention or not)" (Steffensen et al. 2016: 82).³ Accordingly, another important methodological principle concerns the focus on the cognitive results from which the analysis starts. In evoking this principle, CEA's procedure spans from identifying a cognitive event to identifying the event pivot(s), followed by data annotating and segmenting of the cognitive trajectory, and finally, by conducting an analysis of how the segments and specific changes configure the cognitive trajectory. (For an in-depth overview of the steps, we refer to Steffensen et al. 2016).

³ In scrutinizing the nonlinear path of a given cognitive ecosystem, the researcher furthermore regards how event pivots might be configured as part of the agents' coordination with serendipitous or happenstance conditions. This is, for instance what happens in a problem-solving case when the agent observes a "serendipitous overlap of pens" which leads the agent to the right solution (Steffensen et al. 2016).

Overall, by investigating cognitive events, the researcher is able to consider multiple time-scales, since the methodological focus is not reduced to either a priori assumptions about behaviour or to a step-wise procedure (as with CA's turn-by-turn-sequentiality; cf. Trasmundi 2016). Rather, CEA investigates the interactivity of living human systems.

3.2 Interactivity and organizing

In organizational science, analysis of concrete interactions in organizations has been dominated by a focus on organizational culture, collective behavior and psychology (Mejlby et al. 2010). What these frameworks miss about organizing is the multitude of coordination and uses of resources that shape not only the organizational macro level (e.g., social norms, routines, procedures) but go all the way down to the pico-scales of human interactivity. The concepts developed within the framework of interactivity – such as non-locality and sense-saturated coordination – are useful for analysing multiple levels of human organizing. The importance of an interactivity-based view on organizing is underlined by the emergence of hospital errors: Up to “80% of medical mishaps are caused by human factors related to interpersonal interaction” (Schaefer et al. 1994). The most frequent errors are those related to medication. In our SimLEARN-project, we use cognitive ethnography (Hutchins 2014) and dialogical action research (Alrø & Hansen 2017) to study the occurrences of such errors in the everyday interactivity of medication practices.⁴

As part of the ongoing SimLEARN project, it was observed how a focus on interactivity can inform organizational change: On a walk-along with a nurse, researchers Malte Lebahn and Lotte Abildgren noticed how the medicine room of the ward was a so-called “no interruption zone” thus having the purpose of letting staff concentrate on preparing medicine. But this zoning changed when an elderly patient accidentally dropped one of his pills on the floor. The nurse now needed to find a substitute. This was a difficult task since the pill had a generic look and was therefore not easily identifiable. In solving the task, the nurse coordinated extensively with environmental resources, including computers, pill boxes and other nurses as checks and balances. The interesting part was how this coordination took place inside the medicine room as a “no interruption zone”: Only by breaking the non-local rules and having many local interruptions back and forth between the nurses, the substitute pill was eventually found. The nurse explained that he perceived the “no interruption zone” as an intimate space and that it was this reconceptualization which allowed for the constant interruptions. The reconceptualized medication room was as a non-local resource that enabled the sense-saturated coordination of finding the right substitute pill.

The field observation shows how the nurse had to rely on both localised (other nurses, pill-boxes, etc.) and non-local resources (e.g., the different social norms pertaining to the “no interruption zone”) in order to solve the issue at hand. Moreover, it provided the agent of organizational change with an invaluable perspective on how human interactivity constitutes medical practices, thus allowing us, the observers, to understand how different resources constrain the flexible adaptive behavior of medical professionals.

⁴ SimLEARN is a project funded by University of Southern Denmark, Odense University Hospital, and Hospital Sønderjylland.

3.3 Interactivity and reading

The present sub-section outlines how we can study reading within an interactivity-based perspective. Rather than treating reading as a mental process used to interpret text, an interactivity perspective replaces such a code-view by due attention to the embodied and multi-scalar nature of the activity (Cowley 2011). While an interactivity-based perspective encourages studies to adopt a multiscale view on reading, it opens up for a historical, sociocultural, and dynamical perspective on how specific forms of sensorimotor coordination are enabled and managed (Pedersen 2015; Steffensen 2013). Accordingly, we understand distinct forms of reading as distinct forms of sensorimotor coordination, uniquely characterised by certain features of their coordination dynamics (Trasmundi & Harvey 2018). Such unique forms of reading can be characterised as *reading ecologies* that might diverge with regards to the materiality of the text, the reading location and the reader's history with reading. For instance, the materiality of the text as well as the ability to manipulate the text and the setting during reading is crucial for the reading experience and learning outcome: how we use hands to fetch the text, fingers to turn the pages or touch the keyboard, the voice to bring forth aesthetic and rhythmic flow and, as we experience the results, we write notes, imagine sounds, use gestural and visible expression and give structure to information. This view leads to empirical questions such as: What are the prerequisites of experiential reading? To what degree are they a matter of genre and format (scientific texts; poetry), medium (laptop; iPad; print book), purpose (task-based; (re)creative; informational), environment (materials available such as pencils, rulers, music, as well as the actual location for reading), etc.?

Studies pursuing answers to such questions will generate a deeper understanding of *what* students do *when* they read, that is, *how* their tactile engagements with the texts are enabled and how embodied interaction is constrained by different mediums, tasks and genres. This perspective is crucial, we argue, as the literature is scarce when it comes to explaining *how* and *when* readers apply different embodied strategies (such as voicing, drawing, note-taking, touching, gesturing, underlining, etc.) to give the text a different materiality or 'life', and what function these strategies have for the reading experience and learning outcome, respectively. However, in focusing on interactivity, we are not only interested in the characteristics of embodiment as they are enacted in the here-and-now. While reading involves not only the whole body (as a multi-sensory organ), but a historical, skilled body that affects the reading ecology in which a reader is embedded, reading must be viewed as distributed. Thus, reading is not only a matter of drawing on multiple modalities in the here-and-now that together become a conglomeration of the human sensorium. "Skilled linguistic action allows for construing symbolizations as neurophysiological processes re-evoke parts of an individual's life experience of encultured social activity. Embodiment thus, involves a perspective that links multiple timescales and goes beyond local coordination" (Trasmundi et al. forthcoming).⁵

5 On a par with this line of thinking, Mar (2018) has investigated how readers' engagement with fictional stories is tied to social cognition. Stories enable readers to understand cognitive-social phenomena in real-life interactivity as they allow the reader to link previous experiences with different potential scenarios in ways that can expand understanding.

Reading is thus understood as saturated by non-local dynamics (Steffensen 2013; Harvey et al. 2016), that is: readers draw on cultural and individual past and absent resources which shape particular behaviour in the local (Steffensen & Cowley 2010). Similarly, Meyer et al. (2017) argue that we need to integrate the fast, microscopic perspective on unfolding events in time with a slower perspective on the sedimentation of habits and culture, as well as with the emergence of artifacts and methods to grasp the multi-scalarity of particular activities.

3.4 Interactivity and trace-making

Although much of the research in interactivity studies looks at coordinative dynamics in the intercorporeal here-and-now of dialogical systems (Steffensen 2012), one can reasonably expect a concept that is as broadly defined as is interactivity to also have something important and interesting to say about people's coordination when they are not together. For example, one might ask whether, when we receive handwritten Christmas cards from family or friends, the flow of their handwriting makes us feel their presence more than if their words had been typed? Also, does the appearance of their handwriting make a difference for us?

Hand movements can be highly expressive, as evidenced by even casual observation of classical music conductors or of Polynesian dancers. In fact, studies of sign languages reveal the equivalent of *affective prosody* in signing gestures (e.g., Hietanen et al. 2004; Reilly et al. 1992). Not only have affective prosodic structures (in e.g., tempo, rhythm, and size of gestures) been identified when signers *make* utterances in different emotional conditions, but on the *perception* side “[...] signers are capable of recognizing different emotional states from manual signals alone” (Reilly et al. 1992: 113).

If indeed (i) gesturing hands are capable of making such fine-grained affective prosodic distinctions, and (ii) people do indeed affectively attune to them, it is reasonable to suggest that (iii) hands holding graphic tools are no exception and that (iv) graphic traces caused by hand-tool gestures record and retain that prosodic structure. If so, handmade traces may allow a perceiver, through her own sensory-kinetic history of gesturing, to embody (a version of) that prosodic structure, thus setting up the graphic and non-coextensive equivalent of British phonetician David Abercrombie's idea of “phonetic empathy” (Abercrombie 1967: 97):

The speaker [...] is simultaneously also hearer (he must be, for the normal conduct of speech); but the hearer is, in a way, simultaneously also speaker (at least when listening to his mother tongue) in so far as he ‘empathically’ enters into the speaker's sound-producing movements, sometimes making tentative movements of a similar nature himself (Abercrombie 1967: 23).

One might refer to such a phenomenon as *graphetic empathy*. Studying it would require a two-pronged method by simultaneously, on the one hand, looking at the sensory-kinetics involved in the making of graphic traces and the psychophysics involved in their perception in order to describe prosodic structure, and, on the other, looking at the micro-phenomenological experiences of makers and perceivers in order to describe their potential for affect.

3.5 Interactivity and design

Interactivity constitutes a foundational element in participatory design practice, being concerned with understanding human activity from an ecological perspective in which the cognitive, social and material are deeply intertwined. In this sense, humans and artifacts are seen as active participants in their respective ecology, where specific groups of persons have the role of facilitating other humans in gaining the most from the available artifacts (Nardi & O'Day 1999). For instance, while investigating the design of assistive robots for elderly care, we notice how caregivers constitute such a group, in charge of facilitating the residents' use of the available artifacts, such as different medical devices, and their acquiring new ones from which they might benefit. In this sense, the coordinated actions of residents and caregivers in using available artifacts provide an invaluable source of inspiration to make sense of elderly care ecology and envision new assistive technologies.

Methodologically, participatory design approaches interactivity through ethnography, combining a spectrum of observational and dialogic practices, aiming at making sense of human practices, with the goal of enriching them (Björgvinnsson et al. 2010). At the same time, participatory design is itself interactivity, involving performative practices such as co-design workshops, in which designers and users engage with making and trying out mock-ups, enacting together possible future scenarios (Björgvinnsson et al. 2010). Introductions and tests of mock-ups create room for negotiation and exploration, in which technologies are constructed through coordinated embodied interactions, challenging existing practices, tacit routines and expectations (Lee & Riek 2018).

In a recent experiment on assistive robots for elderly care, we observed how a robotic mock-up challenged tacit routines assumed in daily mundane interactions, such as walking along the corridors of an elderly care centre. First of all, even though there has been increasing interest in designing anthropomorphic and zoomorphic robots, it has been showed that elderly and their caregivers prefer to have a clear separation between living and non-living beings acting in their ecologies (Marchetti 2019; Wu et al. 2016). This preference seems to be caused by a fear of being misled, but also by the desire of being able to freely dispose of robots as tools. For instance, caregivers expressed the desire to physically restrain robots from entering residents' private rooms and other areas for hygienic reasons, without involving unnecessary concerns for nonexistent emotional states, which instead would be considered for living beings. Interestingly, while enacting a guiding scenario, in which the robot was supposed to guide residents to dining areas, residents started to engage in small talk with the prototype, indicating the desire for a social interaction. However, concerns emerged on appropriate social protocols, such as whether the robot should take initiative talking to residents and what physical distance it should keep, so as not to intimidate them.

Introducing material mock-ups into human practices brings to light an intricate fabric of embodied, sense-saturated interactivity, enabling people to rationalize their routines and assumptions on what they do, hence providing opportunities to re-configure current practices at different scales, from apparently obscure details, such as physical distance, to complex social interactions.

3.6 Interactivity and social presence

An interactivity-based perspective on social presence allows to investigate how people co-enact relationships while they are physically absent. In computer-mediated communication, Biocca and colleagues define social presence as the “sense of being with another” (2003: 456). They reduce this ‘feeling’ to a medium’s features, which evoke mental representations in the ‘mind’ of another individual. In this media-deterministic approach, the phenomenon is both situational and intentional. From an interactivity-based perspective, however, non-local events and resources saturate interpersonal digital interaction.

To study how interactivity enables social presence, Fester-Seeger (forthcoming) explores online conversations (i.e. texting) in relation to longitudinal ethnographic data and interviews. In one example, Fester-Seeger (2018) shows the importance of past experiences that act as non-local resources. Two friends misjudged each other’s tone of voice in an online conversation. Participant one (P1) was unable to detect participant two’s (P2) intended sarcastic tone of voice. To overcome their predicament, P2 proposed to use an indicator for sarcasm in their texting. Soon, they settled on the slash sign as a marker for their way of doing sarcasm (see Figure 1).

1 P2: (Måske vi bare skal sige at hvis man råber ting er det tydeligt det er sarkasme for jeg tror vi begge to har et sarkasme problem som er at vores humor ikke er sjov for andre end os selv og vi derfor bare siger ting og det skulle forestille sarkasme)

2 P1: (jeg tror du har 100% ret)
Hvad var det sarkasmetegn, du opfandt, jeg har glemt det

3 P2: Det har jeg også Var det et tysk dobbelt – S?
Måske bare skråstreg ville fungere
/dine sko er grimme/

4 P1: omg ja

1 P2: (*Maybe we should just say if we scream things then it is clearly sarcasm because I think that both of us have a sarcasm problem that is that our sense of humor is not funny for others but ourselves and that's why we just say things which should be sarcastic?*)

2 P1: (*I believe you are a 100% right*)
What was the sarcasm sign, you created, I forgot about it

3 P2: *I did so too... Was it the German sharp s? Maybe a slash sign could work /your shoes are ugly/*

4 P1: *omg ja*

Figure 1. Excerpt from Facebook Messenger conversation (left: Danish original, right: translation by Fester-Seeger).

This was no arbitrary choice. In the group interview, P2 tried to imitate the tone she ‘hears’. She showed that not only tone but also gesture mattered. In addition to her sarcastic tone, she also enacted a certain bodily movement (see Figure 2).



Figure 2. P2 enacting her way of doing sarcasm.

She repeated the movement twice. Consequently, P1 copied P2's action. She suddenly remembered that the movement arose from a prior interaction with a common friend (see Figure 3). In this moment of realization, she turned to P2 and they both enacted the movement in coordination. In this small bit of togetherness, they explored the reason for their choice: the slash sign seemed to resemble their tilting movement. The retrospective exploration allowed them to unearth a past event from their interpersonal history that made them unintentionally resemiotise the slash sign.

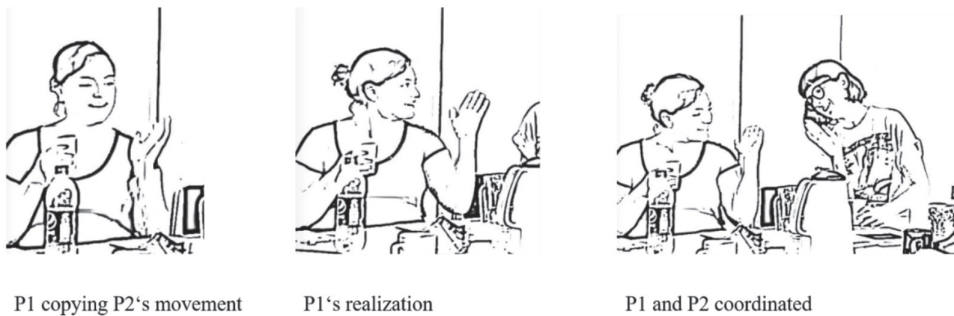


Figure 3. P1's realization of the origin of the movement.

Vivid re-iterated direct engagements enabled the participants to slowly attune to bodily makers (e.g. voice, pitch, facial expressions and distinct gestures) and to create interpersonal events that influenced their situated engagement in a medium. Sense-saturation, therefore, brings about 'sensing'. To 'hear' someone's voice or to 'imagine' a friend relies on past coordinative dy-

namics. The saturation of experiences and lived temporalities enable felt embodied presences in online communication.

3.7 Interactivity and digital consultation

Online communication between general practitioners and patients are enabled via digital consultations, i.e., short written messages and via functions like prescription renewal and booking of physical consultations. The overall purpose of studying interactivity in relation to this platform is to elicit knowledge about the ways in which the usage of digital consultations influences the abilities of GPs and patients to engage with health and healthcare. In doing so, we focus on how medical activities (e.g., diagnosis and treatment) are enabled and conditioned by sociotechnical constraints of the digital consultations as they potentially emerge in inter-bodily dynamics as an integral part of a larger medical-cognitive ecosystem (Hutchins 2014). Sociotechnical constraints can be described as *affordances* (in line with Gibson's terminology; 1979) of the digital consultation (e.g., previous messages from the patient, lab results, the medical chart), by which it is argued that the usage of digital consultation before, during and after physical consultations influences the way the GP's medical expertise is organized.

Expertise in face-to-face and digital encounters can, in this setting, be investigated as the agent's abilities to align multiple non-local, sociotechnical constraints with local, interpersonal dynamics – a *hybrid cognitive manoeuvre* (Simonsen & Steffensen 2019). Specifically, this refers to how digital consultations saturate the physical, inter-bodily dynamics in local encounters with the patient (e.g., when a GP says to a patient in a physical consultation: “you wrote to me that it feels like you are walking on a pillow”). Put differently, to enact medical expertise (e.g., diagnosing the foot issue), the GP relies on aligning different non-local ecologies, such as those who refers to the organizational ecology in the clinic (e.g., medical procedures) and say, former information afforded by the ecology of the digital consultations (e.g., the mediated interaction) with the interpersonal dynamics in the physical consultation with the patient. In doing so, the GP solves the medical task as the s/he engage in an extended ecology (Steffensen & Fill 2014) on digital and physical scales.

This perspective requires an epistemological shift from traditional dualist and representationalist analyses of semiotic structures and resources to interactivity. More specifically, one has to see the practice of digital consulting as ecologically embedded while it pivots around saturated dynamics in the actual lived medical-cognitive ecosystem. Thus, it makes sense to approach the digital consultation as a multi-scalar phenomenon since it is shaped by both past physical and digital consultations, sociotechnical artefacts (e.g., different hardware and different software in use), as well as sociocultural norms and structures (e.g., verbal patterns and organizational procedures). When, for instance, a GP refers to her/himself as a ‘mail reader’, the deictic orientation refers to a particular procedure for the GP's way of managing the mails from the digital consultation. Thus, the enaction of the role as a ‘the mail reader’ suggests an inter-agentive collaborative practice influenced by the sociotechnical constraints of the digital practice.

The project's preliminary findings suggest that, with interactivity, it is possible to identify how digital consultations (i) influence and are enacted in GP-patient interaction patterns, and (ii) influence organizational behavior and collaboration in general practice. Potentially, this leads to new understandings of sociotechnical dynamics and medical expertise in general practice (Simonsen forthcoming).

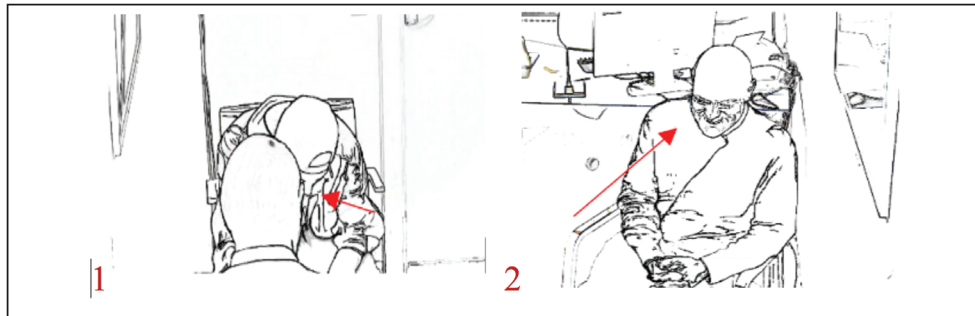
3.8 Interactivity and psychotherapy

Human interactivity depends on the human-specific ability to coordinate actions to pursue species-specific goals. One type of activity where this becomes evident is the psychotherapeutic encounter. The success of psychotherapy depends in some measure on the patient's willingness and ability to talk about past experiences of self and others. The therapeutic project thus relies on the practitioner's guidance to get the patient to elicit talk in order for the practitioner to get a better understanding of problematic behaviour, and to allow the patient to account for the problem in his or her own terms (Bartesaghi 2009). By guiding, the therapist prompts the patient to orient more to the deontic concern (of engaging in the therapy) and not so much on epistemic rights and obligations (Muntigl et al. 2017). In the following, a small data sample from a case study of psychotherapeutic practice is used to illustrate how human sense-saturation draws on complex bio-social conditions and non-local resources.⁶ The sample stems from video-recordings of session of therapeutic treatment, and involves a psychiatrist (M, 60+, trained in Mentalisation Based Therapy) and a patient (F, 19, diagnosed with borderline personality disorder).

In the time leading up to the extract, the dyad has been negotiating the rationale for talking and disclosure. A tug of war develops, with the patient on one side, hesitating to talk, questioning the purpose of talking, or being silent, and on the other side, the therapist prompting her to talk in an emphatic and psycho-educative manner, or being complementarily silent. The situation is tense. Talking seems tormenting to the patient, and the silent periods seem to be tormenting both. The patient finally challenges the struggle by pointing to the absurdity of the therapist saying "we need to make use of the time we use together". Notably, the patient's initiatives to talk have been sparse till this point, and her snappy reply "we have a full year's time to talk" could be interpreted as yet another excuse for her to resist talking. Thus, if her reply is to be taken at face value, it would potentially do further harm to an already weakened relationship, as exhibited by, on the one hand, the therapist's concerned frown and, on the other, the patient's closed body posture.

The response shows differently. The therapist replies with a laugh. Clearly, he somehow knows that the utterance was not to be taken seriously. In response, the patient smiles cheekily. Rather than considered inappropriate, the laughter is increasing the dialogicality of an otherwise asymmetrical relationship.

⁶ Source: the EPICLE project (An Ecological Perspective on Psychotherapy: Integration of Cognition, Language and Emotions). Data consists of video-recordings of psychotherapeutic sessions, i.e., encounters of therapist-patient dyads (a.o.t.) at an outpatient clinic at a psychiatric hospital in Denmark. The therapeutic program is funded by state submissions. (Used by permission; translations ours)



1 2

PT: [no] (.) so (.) there you go!
 TH: Mm
 PT: Are we done then?
 TH: No. There is still time
 PT: yes and?
 TH: We have to make use of the time we spend together
 PT: We have a **full year's** time to talk (1)
 TH: **heheheh** .h yes (2)
 PS: (3.0)

We are witnessing the emergence of a dialogical system constituted by a sudden shift in the shared attention of the interlocutors relying on inter-bodily dynamics that, in a blink of a second, come to afford a different way of being together. The patient pronounces “full year’s time” with not only emphatic stress but also with a slight sneer. Furthermore, in this very moment, she lifts her face a tiny bit thus enabling a hint of a glance. Anticipating nonseriousness is thus cooperatively enacted by the patient and the therapist as a reorganization of their joint attention. Humour emerges in the spontaneity of inter-bodily dynamics thus paving the way for a sudden shift in the interactive flow (cf. Jensen 2018). Also, it gives evidence to how humans engage in sense-saturated coordination bearing on smaller faster timescales, that is, the reciprocal flow of minuscule, pico-scale inter-bodily movements that link and lock human beings in self-organized systems, and enable co-action, co-thinking, and as in this example, co-feeling (Steffensen 2013: 197).

4. Current and future challenges for interactivity-based perspectives

At present, interactivity-based approaches are used to productively study cognition, personal and organizational behaviour, and individual lived experience. In each case, several of these studies are pursued at the same time, and this is part of the strength of approaches based on the concept of interactivity: they turn the researcher's attention toward interdependencies, contingencies, interactions, and effects that cross boundaries of different kinds. In some cases, these boundaries are temporal, as in the research on tracemaking and perception described in section 3.4, where the investigation will examine how the pico-scale process of reading depends on, and gives access to, the slightly longer-scale processes involved in writing in a different time and place. In other cases, the boundaries are those of modalities or media, as in the case of research on interactive robots, social presence in texts, or the integration of digital consultations into medical interactions. In other cases, the focus on interactivity quite simply allows researchers to ask questions that otherwise would not arise if the topic were approached differently, as in the case of research on hand hygiene and cognitive events.

But this means that interactivity-based approaches face a tremendous challenge. Interactivity is a complex idea and it is still in need of elaboration. However, such future elaboration has to strike a delicate balance: On the one hand, one can imagine a development towards straightforward instrumentation and operationalized measures, but however useful that might be for developing a field and conceiving research projects, it might also lead to dogmatism. On the other hand, one can imagine a broadening of the concept, so it comes to encompass more phenomena and explanatory models. However, there is a risk that the concept of interactivity is broadened out of existence, and thereby lose its ability to help researchers ask new and interesting questions about familiar topics, behaviours, or circumstances. Divergent interpretation itself is not an issue, and certainly dogmatism would not serve interactivity-based approaches any better than vagueness. In between these two extremes, there is a need for a concerted effort where bottom-up empirical work on human behaviour in different settings and under different conditions go hand in hand with top-down theoretical explication of what counts as interactivity and what does not.

The research programmes described in section 3 share two elements: a focus on small-scale details of coordination between people (and between people and their environments), and an interest in how those details relate to lived experiences that are distant, different, anticipated, or passed. These are the elements of coordination and sense-saturation, respectively. To lose sight of either of these would be to abandon an interactivity-based approach, and it would turn those projects in other directions. For instance, if the work on psychotherapy described in section 3.8 were to abandon its interest in linking the description of articulatory, facial, and manual gestures to population-level behaviours (such as 'doing funny'), it would present a catalogue of events but would not be able to draw meaningful connections between them. Similarly, if the analysis of handwriting described above were to restrict itself to assessing emotion during reading and writing, without attempting to identify which features of the pen strokes were perceptually significant in eliciting emotional responses, it would no longer have the potential to reveal something new about what guides human behaviour and produces human experiences.

Overcoming these two challenges does not require any strict adherence to procedure or theoretical prescriptions, but rather a continual and repeated return to two core ideas: that experience and behaviour arise from (a) interaction dynamics and (b) non-local resources, however those are described, conceptualized, or operationalized. Over time, more than one useful operationalization will be established, and many distinct interactivity-based approaches will emerge, and this can only be a good thing.

Already, there are clearly at least four distinct types of interactivity-based research. The first two are formal and informal qualitative approaches. The formal approaches involve methods like CEA (Steffensen et al. 2016) and other tools still in development (e.g., Trasmundi & Harvey 2018). The informal ones are more open-ended explorations of how technological objects (such as digital consultations, text messages, or robots) or institutional rules (such as hygiene guidelines) are instantiated as interactional behaviour (e.g., Pedersen 2015).

In addition to these, some recent work based on interactivity has been truly quantitative, adopting a more structured, constrained, and rigorous approach to identifying the relevant interactional contingencies (e.g., Wiltshire et al. 2018). And finally, there is also theoretical and philosophical work being done that is based on interactivity, such as Gahrn-Andersen's (2019) exploration of the materiality of language, or the discussions that have taken place about the links between interactivity and other, related approaches, such as enactivism (Harvey et al. 2016), dynamical systems thinking (Steffensen & Harvey 2018), and dialogism (Steffensen 2015).

It is vital that all of these strands of research persist, and that they continue to challenge and reshape each other, as well as our understanding of interactivity. So long as the concept's two core elements are kept in view, and the questions that are asked push the boundaries of our ability to answer them, interactivity-based approaches will contribute substantially to our theoretical and empirical understanding of human lives.

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