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## Some epistemological considerations on relation between cognitive psychology and computer interfaces (on the example of tactile-proprioception synergy)

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### Introduction

The sense of touch is of particular importance for virtual environments as it is supposed to offer tangibility to virtual objects. However, to do so, we have to deal with an epistemological difficulty: on one hand, it seems that we need an advanced knowledge on human perception to improve these devices, while, on the other hand, the acquisition of this knowledge supposes already an advanced development of interfaces as measuring devices.

But what are we measuring when, in cognitive psychology, we use for example a forcefeedback/tactile device to explore a tactile dimension in haptic perception? As it will be explained below, the categorisation of the tactile dimension is problematic. To which extent can we then postulate the knowledge of the sense of touch “as it is” in human? What is an epistemological status of these devices?

A contrario, when implementing a new interface for gesture interaction, to which extent can/should we reproduce what we know on the “natural” sense of touch?

Furthermore, to which extent the emergence of the experience for the user is determined by this knowledge of the sense of touch? Can we stretch to say that finally we are studying more the emergence of new aspects of interaction than a “real touch as it is”?

To sum up: On which epistemological basis to study the emergence /the perception of objects in VR? Are the interfaces the goal of the studies on human perception or are they a mean for such studies?

In conclusion, we will present in which sense an enactive approach could overcome this epistemological difficulty.

### Tactile-forcefeedback interfaces

Let's consider the relation tactile – force perception, as studied in cognitive psychology by means of interfaces, more in details. We will present some points showing that this question still needs a basis on which a categorisation of the relation between the tactile and the force perception could be made.

(i) when investigating the synergy between tactile and force perception, the difficulty is considerable. In certain situations, tactile and force information seems to be redundant, in others complementary. What is called “tactile” in real situations is not clearly defined and tightly linked to the force perception, and there is clearly a lack of hypothesis concerning the relation between tactile and force perception.

(ii) various information could be considered as tactile. This variety leads to the fact that, most often, only one or two aspects or “components” will be chosen in order to be implemented in HCI.

(iii) even inside a chosen aspect, the tactile stimulation is relatively poor and not comparable to the richness of the tactile sensation in real situation,

(iv) these devices are conceived on the basis of hypothesis which are, at the actual stage, “exploratory”.

(v) this implementation can proceed only by a metaphor, been given the fact that the tactile interface can not reproduce the richness of the tactile sense. These metaphors can be either functional, either physiological (or a mix of both). Thus, what is called “tactile” in an interface is essentially depending on the model and metaphors implemented.

(vi) and last but not least, the tactile can not be clearly separated in experimental conditions since it is still stimulated through the grip of the FFD (in other words, the conditions of tactile stimulation

are changed, but not absent: contrary to the “natural” situation, the user’s hand is in contact with the rigid grip (in case of FFD only) or grasping a rigid grip with only local tactile stimulation.) This seems sufficient to some extent for the perception of the texture but may not be sufficient in other situations (for ex. in prehension tasks, tactile as control of the pressure applied by the user or as detection of a relative movement).

(vii) Obviously, a knowledge on some aspects of perception can improve the interaction by addressing critical limitative points (for example physiological limitations) in some chosen and controlled situations, and thus to improve haptic interfaces in precise conditions of certain critical tasks. But this does not yet prejudice on the emergence of the sense of the object for the user as such sense is a result of the interaction, and can not be understood when isolating the human “as it is” on the basis of an objectivist position. We have to be attentive to the fact that in this case, the knowledge on human perception is model/metaphor-device- task depending.

The separation between the tactile sense and the force perception is not in human, but rather in the specific devices : in natural perception, tactile sensory feedback and force-feedback are difficult to separate and they always go together. Thus, the categorisation can be made only on the basis of the devices we have today at our disposal, and which aim to explore the role of the tactile dimension by separating it.

The points above show that there is a gap between what one thinks the tactile “is” in human perception and what one wants/can implement. Thus, from the epistemological point of view, the starting point should be the necessity to be attentive to all of these points: the first thing is to do the spadework on this field and to find out on which criterion the categorisation of the relation between tactile and force perception can be made.

## Conclusion

From an epistemological point of view, several consequences could be discussed.

1. If the understanding of the sense of the touch itself is conditioned by studies using specific interfaces, then the interfaces play the role of “categorisation devices”. In a certain sense, the situation is similar to a well-known metaphor of “telephone exchange” which was used to “explain” the functioning of the central nervous system, as well as to the metaphor of computer in computational paradigm of cognitive processes. However, here the devices go behind a simple metaphor or an explicative model as they serve as measuring devices.

2. Furthermore, if the sense of touch cannot be approached otherwise than through the situation of interaction, it means that this sense is mainly constituted by the interaction, and requires an epistemological shift abandoning the objectivism on which the classical cognitive psychology was originally based (i.e. postulating the knowledge of human perception as it is).

3. Enaction in a strong sense, as we understand it (i.e. co-arising of the subject and the world; grounded on the phenomenology as thematisation of lived experience, and “completed” by a recognition of the role of technics in the process of “enacting” of a world of lived experience), could provide such a shift.

In enactivist framework, the relation to the environment as well as the knowledge about this relation are constructed. If we consider the senses as the instantiation of structural coupling (which is “a historical process leading to the spatio-temporal coincidence between the changes of state” of the participants (Maturana, 1975), if we consider the fact that they can be affected by the means of such coupling (here the interfaces), then the notion of enaction can deal with a difficulty to conceive the senses as something constructed, as well in the sense of their evolution as in the sense of the knowledge on them. Then, it resolves the difficulty which we described above as the ambiguity between the use of interfaces in cognitive studies and the necessity of such studies for the design of interfaces; and it even can guarantee an epistemological coherence of the complementarity between them. But the price to pay is to endorse a sort of radical constructivism taking into account the technical dimension of the interaction, and to finally renounce to the objectivism.