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Does projection into use improve trust and exploration? An example with a cruise control system.

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Abstract

We know that the systems which are trusted by the users are more often used, especially in a risky situation where they need to delegate control, but we still ignore largely which are the factors which improve trust in the systems. Our issue here was to explore if the way we present the system to the users will have an effect on their confidence in it.

In this study, we had nine subjects using for the first time a Cruise Control System on open road; before, we present the system to them in three different ways: a function-oriented written presentation (G1); a use-oriented written presentation, “augmented” with difficult situations (G2); a use-oriented film presentation (3). They evaluate their trust in the system on scales before the whole experiment, after the presentation and after the real use. At the end, they also have self-confrontation interviews, where they see the video of their driving and describe their activity, strategies and feelings. We then develop quantitative and qualitative analysis of trust, linked with specific situations of action.

Our results indicate that the presentation of instructions lowers the evaluation of trust (and of efficiency) that conductors have a priori; they had constructed an a priori representation of a CCS that is rather idealistic, and realise, after reading of the instructions, and above all after having watched a film, that its use is not so obvious as they had previously thought. There is thenceforth a drop in trust that nevertheless goes up again after use of the system during driving. We remark, from qualitative analyses of use experience of the regulator in real driving conditions that this drop in trust in the system does not inhibit subjects in their use, and in particular, for subjects who have watched a film of projection into use. They know more of the functions of the system in driving conditions, they produce less distorted reconstruction of the functioning, and they have a deeper level of understanding of the system.

Keywords: trust; use ; cruise control system ; system instruction ; exploration ; driving activity.

1. Introduction

1.1. Delegation of control and trust need

The use of a new technological tool, whether it is a question of human-machine or human-human mediated cooperation, leads to transformation of human activity, often in the direction of a modification of the control and the initiative of the activity by the user. Mastery of the situation and of the power to act can thus diminish; and this loss of control, that is delegated to another human or machine, may be compensated for by trust that it is acceptable. It may be very uncomfortable to delegate the control of an activity to a tool or to a person that one does not trust. People tend to seek emotional comfort and well-being, and in a risky situation which can generate fear for instance, they will need to interact with an object or a person that they trust, to reduce this feeling of fear and to reinstall emotional comfort again. We define this notion of emotional comfort and discomfort (Cahour 2008) as a global feeling, which is dynamically constructed through the affective states (trust, fear,

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surprise,...) lived by a user during a specific activity, and which involves the body and the mind. It is important to consider the comfort/discomfort of the users, besides their efficiency and performance, for the ergonomic evaluation and design, since the effective use of new tools depends on both (El Jaafari & al. El 08). Lheureux & al (2004) find that, among users of the cruise control systems, the two most frequently cited motives, for owning such a system are “comfort” (around 40%) and “not having to worry about police checks” (around 35%), which is, according to us, a typical issue of emotional comfort too.

In a risk situation (such as that of driving a car) and in environments whose evolution is uncertain, human beings are potentially threatened and rendered fragile; they thus need to consider that the tools that they use are reliable and efficient, and that they can predict their behaviour, otherwise they could involve taking personal risks, of accident for instance.

Trust (and distrust, which is its inseparable opposite) has been studied in relation to control of dynamic systems (Amalberti, 1996; Muir, 1994; Rajaonah et al., 2003), often within interpersonal frameworks (Rempel et al., 1985; Josang et al., 2005). Muir and Moray (1996) have shown that the use of an automatic system increases as a function of the trust that is accorded to it, and a new system for assisting driving, that modifies the control of the activity of changing gear, seems to be particularly susceptible to depending on this sentiment of trust; Rajaonah et al. (2003) have in any case shown that the less drivers have trust in a regulator, the more they prefer to deactivate it.

One of the functions of trust is to reduce complexity and uncertainty (Muir, 1994); since one of the characteristics of a complex system is that the interactions between components are unpredictable, when one reduces complexity by making one element in the environment reliable and predictable (trustable), it allows the subject to limit the perceived risk.

1.2. Trust as an affective feeling

(Dis)trust is defined here as a sentiment² resulting from knowledge, beliefs, emotions and other elements derived from lived or transmitted experience, that generates positive or negative expectations concerning the reactions of a system and the interaction with it (whether it is a question of another human being, of an organisation or a technology). Assumed predictability and reliability are at the heart of this sentiment, which implies that the other will not put one in a risky or threatening situation. The subject can thus delegate control to such a system because he knows how it functions and can anticipate its reactions that he knows will not present risk to himself. We emphasise here the fact that (dis)trust is a sentiment and not a simple intellectual representation, constructed upon rational bases. According to us, it is an affective state, since one gives one's trust a little like one gives one's friendship, that is to say, on the basis of diverse indications and prior beliefs, but also on the basis of personal dispositions (which can, besides, vary according to context and mood) and shared relational experience, without always having a clear and exhaustive representation of the reasons that make one attribute or not a feeling of trust (this being just as valid for a system as for a human being). Also trust/distrust has a bodily component and is often associated with release and tension, and with a level of personal control and vigilance; people who trust the system (or person) they interact with, relax their attention and vigilance, whereas they are tense and much more in a controlling position when feeling distrust. Certain authors maintain that trust results from efforts that human beings make to overcome their fears, that it is not a rational reaction faced with uncertainty, but rather a reaction faced with the fear generated by such uncertainty (Gléonnec, 2004). Uncertainty and absence of control over a situation would thus be unbearable and trust would be a need to limit frightening uncertainty. As defined by influent authors in psychology of emotion (Scherer & al 2005, Lazarus 1991, Frijda 1986), affective feelings are generated by an “appraisal” by the subject of the situation/object relatively to his/her psychological comfort (or well-being). The subject in a situation that he/she evaluates as risky

² It is rarely the case in the studies about trust and use of automatic systems cited before, where trust is considered, in a more traditional cognitive view, as a set of beliefs.

and uncertain feels emotionally uncomfortable and needs to feel trust for the object he wants to delegate control to.

We can summarize our representation of trust by saying that, in an actual relation of risk and control delegation with an object, the emotional comfort of the subjects (which is the central motivation for using an assistance system) depends on their level of trust or distrust in the object. When they feel it as reliable (no risky for themselves) and predictable, it then reduces complexity and uncertainty and increases the emotional comfort.

1.3. Trust and presentation of a cruise control system

The device studied here concerns the initial taking into use of a cruise control system within real driving; driving is a risky activity that takes place within a complex and evolving situation, and what is at stake for drivers is to delegate part of their activities (Malaterre & Saad, 1986), i.e. the management of speed, to a new system that they discover. Through his actions and perceptions, the driver tries to understand the system, its reactions and limits, and what he can expect from it. With the cruise control system, the role of the driver changes with respect to control. Instead of acting directly, the driver therefore becomes a supervisor (Scardigli, 1996), notably in ensuring transitions when the system arrives at the limits of its domain of action (for instance when the traffic is heavy, the system is often disconnected with short and non-conscious brakes). The way in which the conductor is informed in advance about these modifications (see the list of scenarios §2.1) then becomes the main aspect at stake. Such understanding and anticipation is initially constructed through the presentation of the system that is made to the driver. It is thus important to detail how the means of presenting the system, in order to try to make it understandable and predictable, will influence trust and use.

It has become classical to distinguish the logic of functioning from the logic of use (Richard, 1983): in the function-oriented logic, one begins from the system and actions on it, towards their consequences, what its manipulation leads to as a modification of the environment and for the subject (“if one does this, one gets that”); in the use-oriented logic, one begins from the intentions of the user, his needs in terms of actions on the environment (“if one wants this, one does that”). This second logic appears to be more appropriate for presenting information to the automobile driver, who is above all guided by intentions of actions and looking for means to carry them out. Sarter & al (1997) also stress that a training based on experience is preferable to a learning focused on the knowledge of the model of system functioning. The remaining question concerns the modes of communication by which this information should be presented: either the classical mode of written instructions or else the audiovisual mode that reproduces the driving environment and the visual context in which actions are performed.

1.4. Hypothesis

We begin from the observation that current written instruction booklets are most often insufficient as accompanying measures for taking charge of cruise control systems. We thus seek to determine what could be the impact of a new integrated approach, called ‘projection into use’, involving the use of a film to immerse the user into the principal evolutions of the driving situations with which he will be confronted.

The objective of this experimentation is thus to test a new means of accompanying the taking control of an assistance for driving, within the general hypothesis that, prior to an initial trying out of the system, the projection into use using a film will allow :

- improvement of the degree of the subjective feeling of trust in the system (identified from evaluation scales and self-confrontation interviews), we think that watching the film of the real situations that the user will encounter (and that could potentially surprise him) can modify the trust that he will construct with respect to the system, and on the appropriation of the new system that he will develop.
- greater exploration during the first try-out, which is an indirect sign of trust; a ‘projection into use’ will facilitate initial taking under control by allowing the reactions of the system in different driving

situations to be anticipated, which will itself lead to more free and exploratory action. The exploration of complex functions will be identified from self-confrontation interviews and video analysis.

- better understanding of the functions and limits of the system following the first try-out, identified from the responses to questions on the functions (see below).

We present here a pre-study with nine subjects, developed in an industrial context (with time constraints and prototype availability constraints) and with an ecological (video recording driving in naturalistic context) and mainly clinical perspective. These ecological methodologies are more complex and time-consuming than with a driving simulator but their ecological validity is essential in our view because we can doubt that risk is lived and treated exactly the same way by a subject when the situation is real or simulated.

2. Methodology

2.1 Ecological and clinical approach

The methodology we have developed emphasises the natural driving activity and how it is experienced by the subjects. It is clinical in the sense that it is a case-study which tries to understand in depth the behaviour of the subjects rather than focusing on quantitative significance of the phenomena. The number of subjects is reduced but we have a large quantity of different types of data concerning each of them.

It is a matter of at the same time observing driving activity in natural situations after different presentations of the system, and of articulating these analyses with what is 'lived' or experienced by subject., in a phenomenological sense (what they thought, perceived, felt, during this activity). In this study, the focus is more on the subjective experience of the subject (through self-confrontation interviews and subjective scales) because we define trust as an affective feeling, highly subjective like all feelings, and not much observable through the behaviour of the subjects. Some emotions, like fear or surprise, can be expressed by the mimics of the subjects, but the feeling of trust is not directly observable on the mimics. For this reason we mainly focused on subjective verbalisations and scales. We have to stress that self-confrontation interviews are kind of a mix between subjective and objective data since the subject is commenting the video of his past actions and perceptions. He/she is using the video of the real activity (objective data) to remember his/her feelings and thoughts at that moment (subjective point of view).

Concerning the behaviour of the subjects, the observable cues which could indirectly be a sign of trust/distrust are not so numerous and are rather ambiguous³. We used one of them as a sign of trust/distrust : the way users explore the functions of the system. During the trial, if they stick to the basic functions of the new system, it shows that they are not very at ease with its use, but if they explore more expansively the different possibilities of the system, it indicates that they are in a mastering and trusting position.

The data is thus constituted of:

- (1) Subjective scales concerning trust in the system filled in by subjects, at three different moments;
- (2) Filmed driving activity; video data of real driving activity;
- (2) Self-confrontation interviews with subjects just after the activity, based on the video-recording;
- (4) Questions on the functions of the system.

We develop each category of data in the following parts.

³ For instance we could have recorded the speed of the vehicle but then we should have compared it to the usual speed of each driver without the new help system in order to build three homogeneous groups; but still the speed depends on the traffic and this cannot be controlled in a natural situation of driving.

2.2 Presentations of the system

Three modes of presentation of the system have been elaborated and presented before driving with the cruise control system:

- G1: a *function-oriented written presentation*, which corresponds to what exists today, being the written user manual;
- G2: a *use-oriented written presentation*, “augmented” with respect to the present situation, using situations that are difficult to manage;
- G3: a *use-oriented film presentation* (i.e. one which is explicit concerning situations that are difficult to manage). This consists of a video recording made of use situations on the real road, filmed over the shoulder of the driver, with his spoken commentaries and those of an expert co-pilot, who explains the system to the driver. The G2 and G3 presentations have very similar content.

The principle and the objective of ‘projection into use’ is to make a scenario of the principal new situations that the user will encounter and which can be potentially a source of surprise or misunderstanding, in order to facilitate his initial use of the system, to reinforce trust and to favour exploration of the system and its functionalities. Different scenarios were presented in the augmented manual, as well as in the film. The goal of the scenarios was thus to be representative of new situations that will be presented to the driver who discovers the system. It should be emphasised that the system that was used was a prototype of an application that is undergoing design.

The list of scenarios, constructed on the basis of a previous study of use of a cruise control system (Timianguel, 2005), that are included in the augmented user manual (G2) and depicted in the film of projection into use (G3), in addition to more classical explanations of functioning, is the following:

- a situation of overtaking a vehicle: illustration of use of the accelerator pedal in order to provoke an intentional state of “over-speed”;
- a situation of a steep hill, for illustrating a non-intentional state of over-speed;
- a situation where traffic becomes more dense, then there is insertion of a vehicle in order to illustrate automatic deactivation of the system following braking, then reactivation by the driver with the “R” button of recall of the memorised speed;
- increase/decrease of speed limit: illustration of the use of the (+) or (-) buttons by the driver, to adjust the requested speed to the speed limit.

2.3 Population

For this study, nine subjects, divided into three groups, were recruited:

Group 1: 3 subjects to whom the basic paper instruction manual was presented;

Group 2: 3 subjects to whom the paper instruction manual was presented, augmented by a description of situations of use;

Group 3: 3 subjects to whom the film of projection into use was presented.

The subjects were shared out between the three groups in a manner that was homogeneous with respect to age and gender. They were all experienced drivers (having each had their driving licenses for at least five years) who had declared that they had never driven with a cruise control system before the test.

Insert figure 1

Each type of data is described in more detail below.

2.4 Subjective scales

The subjects replied to a set of four subjective continuous scales concerning their trust in the system and to related notions that are generally associated to trust in the research literature (Muir, 1994): reliability, predictability, efficiency.⁴

E1: general confidence in the system: “do you have the feeling of trust in the CCS (Cruise Control System)?;

yes, completely ----- no, not at all”

E2: predictability of the system: “according to you, are the reactions of the system predictable?;

yes, completely ----- no, not at all”

E3: reliability of the system: “do you think that the system is safe?

yes, completely ----- no, not at all”

E4: perception of the system’s efficiency: “according to you, is the CCS efficient for controlling your speed?

yes, completely ----- no, not at all”

These scales were completed by the subjects in three stages:

T1: evaluation before any presentation of the system. We thus collect a judgement derived from a priori beliefs of the user about cruise control systems that he has not yet used but about which he has heard of.

T2: evaluation at the outcome of the presentation of instructions in one of the three forms.

T3: evaluation at the outcome of free driving of the system on a journey on the open road of around one hour.

T1 and T2 correspond to a priori trust of type 1, based on indirect information (Numan, 1998; Rajaonah, 2003), T3 corresponds to trust of type 2 which is based on experience of use.

2.5 Filmed driving activity

After an initial discovery session of around ten minutes, carried out on a protected circuit without traffic, a journey of around one hour on the road was undertaken. One third of it was composed of fast roads, and a final third of driving in a semi-urban context.

⁴ Our notion of efficiency synthesises the notions of “competence” and “responsibility” of Muir (1996); our notion of predictability synthesises those of “predictability” and “faith” of this author.

The time of driving was planned in a way so as to obtain relatively reliable and constant traffic for subjects. The drivers were reminded to respect speed limits and to try to use the system that had been presented to them when it appeared to be opportune.

Four cameras were integrated into the car, filming four different viewpoints: (1) a subjective view, corresponding to a view close to what the subject would see in the situation, i.e. essentially the exterior scene from the front; (2) a view of the cruise control system screen; (3) a view on the face and torso of the driver; (4) a view of the pedals. The two first views were used for the self-confrontation interview.

The filmed driving is mainly used for the self-confrontation interviews, but also for studying the exploratory usage as observed in the video.

2.6 Self-confrontation interviews

The use of interviews seems essential to us in order to understand the activity of the subject from his own point of view and to shed light on unclear points of the activity that one could only delimit thanks to subjects' verbalisations, such as: felt emotions that are not externalised, motivations towards action, diverse mental activities that are not directly inferable from observables and that one can only come close to by questioning the subjects with certain methodological precautions, and above all, whilst taking care to put subjects back into memorial contact with the situations they describe.

These interviews were carried out using the videos of the driving activity. After the test in real driving conditions, the subjects were placed facing the videos recorded during the driving phase. Only the "subjective" and "system screen" views were presented to the subject during the self-confrontation interviews, in a manner so that the recently occurring driving situation was reconstituted.

With each major evolution of the driving situation linked to the use of the cruise control system, whether involving a modification of the state of the system (e.g. start-up on the road or disconnection of the system by the driver) or of the driving situation (e.g. entry onto a fast road), the video was paused, and an interview phase was carried out (largely inspired by techniques of Explicitation Interview developed by Vermersch; cf. Cahour, 2008) on what was experienced during the sequence encountered by the subject. Subjects were told that as soon as they remembered an element of what they had thought, perceived, felt or otherwise, at the moment of the driving activity that they were watching, the researcher would stop the video.

The "Explicitation Interview" (Vermersch, 1994; Depraz et al., 2002) is a specific questioning technique that aims to bring the interviewee as close as possible to the specific situation that was lived, in a psycho-phenomenological perspective, and which avoids, by the type of interviewer interventions which help the vivid recall, the possible biases whereby interviewers orient responses and subjects engage in reconstructions and rationalisations. The lived experience that is targeted is just as much of a cognitive nature as affective or corporeal (Cahour et al., 2005).

Lots of researches focus now on the "user experience" and we use here a specific methodology for documenting it, with specific methods of verbalization (self-confrontation with Vermersch's mode of questioning).

2.7 Questions on the functions of the system

After the self-confrontation interviews had been completed, the subjects were asked questions on their understanding of the principal functions of the control system (commands and displays). The aim was to determine whether the different modes of presentation of the system had an influence on the representation of it that the subjects constructed, and on their understanding of the tool. The following are examples of the eight questions asked:

- According to you, how does one know that the control system is active/passive?

- How does one disconnect the control system?
- How does one record the advised speed? ...

The extent to which the three groups of subjects differ with respect to these questions on understanding of the system will be seen below.

3. Results

The data analysis presents the quantitative results along the three scales of trust evaluation that show significant differences, then qualitative results of interviews, the set of which aims to specify the impact of modes of presentation on the evolution of trust and on the use of the new system.

3.1 Evaluations of trust and associated dimensions

The question asked here concerns evolution of trust and associated dimensions (predictability, reliability, efficiency) as they have been estimated on a specific scale, as a function of the three modes of presentation of the system, and according to the three successive phases of the experiment: a priori, after presentation of the system, and after effective use in real driving.

Insert Table 1

Firstly, one notes that the evaluations of predictability and of reliability show no significant change across the three phases of the experiment (and according to the three modes of presentation). We shall therefore go into more detail below concerning the two other scales.

3.1.1 Evolutions in trust in the system

We expected that the viewing of the use-oriented film would immediately improve trust accorded to the system. In effect, trust is generally linked to predictability, and the presentations with delicate situations (G2 and G3) warned users of these situations that could surprise them; our hypothesis was that, having very complete information on use, the subjects would feel reassured and confident in the system.

However, as a first result, we observe a significant lowering ($p= 0.05$) of average confidence with the presentation of instructions (all instructions taken together).

We remark that this lowering is followed by an increase that is also significant ($p= 0.05$), after the test in real driving conditions.

Insert Figure 2

Reminder: The G1 subjects read a basic written user manual; the G2 subjects read a use-oriented paper manual; the G3 subjects saw a “projection into use” film; between T1 and T2, the system was presented to subjects, and between T2 and T3, use in driving was carried out.

On Figure 1, one can observe a more marked change for group 3 of this lowering of trust after the presentation and of the augmentation after use⁵. One could thus think that the film of projection into use, that gives a more realistic vision of the system than the two other sets of instructions, makes subjects more wary with respect to a priori beliefs about the system. The presentation would thus play an important role of a “forewarning” with respect to use, which is undoubtedly not as simple as what the subjects could estimate a priori (this more realistic representation of the system will be explained in more depth by the qualitative analyses). It is interesting to note that these decreases in the estimation of trust go up again after the effective trying out, at least to the level of the a priori estimation, and more strongly than the other presentations.

3.1.2 Evolution of the judgement of efficiency

One observes a significant decrease ($p= 0.023$) of the perception of efficiency of the regulator for controlling speed from the very beginning of the experiment, before any presentation (T1) to the outcome of the real test (T3). On Figure 2, this general effect is observed differently according to the type of presentation of the system (cf note 6): the first two groups (paper instruction manual) become conscious of the fact that, only after use, the regulator does not limit speed in all circumstances, whereas group 3 becomes conscious of this immediately after watching the film.

Insert Figure 3

In this case also one could think that the film allows the subjects to construct a representation that is closer to real use; the subjects of group 3 anticipate the limits of efficiency of the system and more rapidly come to grips with the reality of the proposed system, which can disappoint them suddenly more than in use. One can see on the curves that evaluation tends to increase slightly with use whereas it tends to decrease for G1 and G2.

With projection into use in the form of a film (G3), subjects could be constructing a more adequate representation of the domain of utility with such help, that is more restricted than what is imagined from the beginning by drivers (for example, they realise that in a situation of dense traffic, the system is not very efficient since they have to reconnect frequently after braking).

⁵ We can observe a tendency on the figure but the statistical comparison between groups is impossible because of the small number of subjects.

The qualitative analysis of the self-confrontation interviews that follows aims at studying the lived experience of the cruise control system in a situation of use. In particular, we shall put the emphasis on explaining whether the lowering of trust after the presentation of the system (in particular, with the film presentation) subsequently restrains the action of the subjects in situations of use, taking into account the distrust that is induced, or whether, to the contrary, the realism that it gives rise to allows them to better know and explore the system.

3.2 Qualitative analyses of (dis)trust in the self-confrontation interviews

The analysis of self-confrontation interviews, carried out using the videos of the activity that served as a support for them, allows us to approach the feelings of (dis)trust in a manner that is situated in the action that is in the process of becoming realised, and to link these to precise elements of the situation.

In this section we present:

- qualitative indicators of (dis)trust linked to affects and feelings, verbalised expectation failures and misunderstandings, with extracts of interviews of situations that generate distrust;
- examples of more exploratory uses of groups G2 and G3;
- examples of distorting reconstructions, verbalised by groups G1 and G2;
- levels of understandings of the system after use.

In a first period of analysis, the interviews have been condensed with the help of a coding system that defines patterns of activities in situation, composed of the following different elements verbalised by the user; this coding system has been developed from the content of interviews. We distinguish (1) actions that depend on the perception of context, intentions that were previously elaborated, and perceptions of effects of actions, (2) affective states and physical sensations that will influence actions and mental activities, (3) mental activities (evaluations, expectations, other reflexions and inferences).

- perceptions in situational context (“I was going down a slope”)
- intentions (“I wanted to see how the car would react”)
- actions (“I had switched on the control system”)
- perceptions of the effects of actions (“I see that it went to 50 and not 52”)
- affective states (“I was surprised; I was not reassured”)
- physical sensations (“The pedal felt soft and spongy”)
- evaluations of the situation or of the system (“It was risky”)
- expectations and anticipations (“I thought that the car was going to brake”)
- other reflexions or inferences: they include notably explanatory hypotheses (“I ask myself if I gave it a shot on the brake pedal”) and misunderstandings and questions of the subject on diverse aspects of use.

3.2.1 Qualitative indicators of (dis)trust and problematic situations

Amongst the elements described by the users of the cruise control system, several are potential indicators of the feeling of (dis)trust that is undergoing construction little by little, and which is complex to identify since it is rarely verbalised directly. This feeling can sometimes be expressed

indirectly, but how to know how to ‘see behind’ varied expressions must also be determined. Notably, affective states and evaluations having an affective connotation are relatively direct indications of (dis)trust, and failed expectations and misunderstandings are potential indicators of distrust.

3.2.1.1. Direct indicators linked to affects and feelings

- *Expressed affective states*⁶ : the expression of negative affective states indicates to us that the subject does not feel at ease with respect to an element of the situation of use. One finds numerous expressions of this type in our corpus: negative affective states such as “not reassured”, “uneasy”, “inconvenienced by the system”, “annoyed”, “surprised”, “astonished”, “disoriented”, “disappointed”, “disconcerted”, “worried”, “stressed”, (and of course, “not confident”) allow us to identify elements of the situation that can participate in a feeling of distrust; to the contrary, expressions such as “confident”, “at ease”, “peaceful”, are examples of affective states that indicate that the subject is rather at ease.

- *Evaluations of the situation* are sometimes another way of expressing affective elements linked to (dis)trust: “it’s bizarre”, “I don’t like that”, “it’s astonishing”, “it’s annoying”, “it’s not normal”, “it’s not restful”, “it’s comforting”, are for example expressions that tell about relations that the subject has with the phenomenon in question, links that can participate in a more global feeling (or one that is localised to certain actions and situations) of trust or wariness.

3.2.1.2. Potential indicators of a cognitive nature

- *disappointed expectations and anticipations*: they are a potential source of distrust vis-à-vis the system. When the subject expects a certain reaction from the system and observes a different one, potentially, there is mistrust that arises; negative affects are generally associated with this. Expectations and anticipations are directly linked to the dimension of predictability of the notion of trust.

- *Misunderstandings, uncertainties and questions* with respect to the functioning of the system; the subject who does not understand the links between his actions and the reactions of the system, for example, and constructs a relation of trust; one observes this misunderstanding by the fact that the subject poses several questions or from the fact that he says explicitly “there, I do not understand”. These misunderstandings are sometimes expressed in association with affective states (“I didn’t understand and that worried me”).

3.2.1.3 Qualitative analysis of distrust situations

The following examples are drawn from the self-confrontation interview corpus and illustrate these different indicators of (dis)trust (in italics) and the types of situations that provoke them: situations of exceeding the speed limit, situations of overtaking a vehicle and situations of gaps between the real speed and the displayed speed.

⁶ Most authors in psychology (e.g. Oatley & Jenkins 1996) distinguish the “basic emotions” which have an important physiological and expressive component, from the moods (lasting longer), feelings/sentiments (like friendship, love, trust,...); we consider here all the affective states, including basic emotions and more complex sentiments, which are relevant in regard to the activity and situation. We do not follow Damasio’s definitions of emotions as not being conscious, and feelings/sentiments as being conscious (Damasio 2003).

A) Situation of excess speed

After having fixed an advised speed, when a subject accelerates or is going downhill, and the real speed exceeds the advised speed, he is therefore in “excess speed” or “over-speed”; a red band lights up to signal this to him, but the system does not deactivate itself, and takes over control when the vehicle comes back to the advised speed. However, novice users often expect that the cruise controller will stop them from going beyond the requested speed (but automatic braking is technically too costly). One sees in the following descriptions by different drivers that this disappointed expectation in the case of over-speed, poses problems to subjects who say that they are “surprised”, “disappointed”, “untrusting”.

N.B.: patterns of situations presented here take up a “selected verbatim” of verbalisations of subjects, in other words that the groups of words are selected, and not always the complete sentences, with their hesitations, reformulations, etc.

In the example 1, one observes that the subject, remarking that his vehicle exceeds the advised speed, expresses his disappointment and his lack of confidence given the fact that the system does not do what he asked it to, which implicitly calls its reliability, efficiency and predictability into question; it seems that the subject had not perceived that he was going downhill or had not understood the fact that the system did not brake. In the same kind of idea, another subject (example 2) also expressed his surprise to see that the requested speed was exceeded, given that he had effectively perceived that he was going downhill, and he inferred from this a problem for respecting the speed limit.

Example 1

Action = “I asked for 69”

Context perception = “and all of a sudden it is 76; the red bar lights up”

Evaluation = “thus for me control is not carried out”

Affect = ... (sigh) ... “I am a bit *disappointed* by the system; I do *not have confidence* in the system, not on the level of security but on the level of not doing what I asked it to do”.

Example 2

Context = “I see that we’re going down a slight hill”

Affect = “I was *surprised* to see that we were going faster than the speed I asked for”

Inference = “you should not use the control system for radar speed detectors since they often put them going downhill”

There again (example 3), the subject says that he is “surprised”, “disappointed”, and finds it “a bit strange” to be able to exceed the advised speed. The expression “I thought that the car was going to brake” clearly indicates a disappointed expectation, which allows one to suppose that trust is threatened. It must be emphasised that the fact that on several occasions subjects expressed their disappointment and lowering of confidence is not due to a feeling of risk of accident, but rather above all to the fact that they are unable to predict the reaction of the system.

Example 3

Action = “I’m coming out of the roundabout; I put on the R again with the button”

Context = “I am at 57; the advised was 52 and the red bar is lit up because I went beyond it”

Affect = “at there, *surprise*”

Reflexion/expectation = “*I thought that* the car was going to brake automatically; I said to myself that it should brake automatically or at least control it in the direction of lowering speed, this being something I did not feel”

Sensation = “perhaps the machine does it, but I did not feel this phenomenon”

Affect = “I do not feel in danger but I am a bit *disappointed*; it seemed to me to be a bit *strange*”

B) Situation of overtaking a vehicle

The situation of overtaking a vehicle does not pose a specific problem with the speed regulator, but subjects do not feel confident with it because they do not know how to precisely anticipate how their vehicle is going to react with the regulator. They know that when they brake it will deactivate, but they do not always have clearly in mind the fact that they can also go beyond the advised speed by accelerating whenever they want to. Thus, the two subjects described their hesitation, embarrassment, tensing up, being blocked and fear when they wanted to overtake. It should be emphasised that we are here in a situation of first use of the system, and that trust can be established over time.

Example 4

Perception of context: “I was the one who had to pull back in”

Action = “I didn’t know what to do; either brake, or else accelerate and go past; I had a period of *hesitation* that I found enormous”

Affect = “I felt a bit *awkward* with the system; the fact that it was assisted by something disturbed me; I was a bit *tensed up*”

Perception/expectation of effects = “I didn’t know how the car was going to react”

Affect = “so at that instant it made me feel *blocked*”

Action 2 = “I ended up by braking then afterwards I re-accelerated because I had seen that it had cut out (the control system, given the fact of braking) and I felt that I was no longer pulled forwards”

Example 5

Affect/expectation = “My *fear* was to find myself stuck to the ass of a lorry, of wanting to overtake and that the control system was going to prevent me; an *anxiety* but when I say anxiety .. I feel myself neither in difficulty nor in danger ...”

Action = “I perhaps pressed down a bit more on the accelerator pedal”

Intention = “to see if the fact of pressing on this pedal was going to allow me to go beyond the advised speed.”

C) Situation of difference between the real speed and the displayed speed

In the following example, a subject describes a slight difference, produced by the prototype, between the speed that the subject wants to record whilst driving (his current speed) and that which is displayed and recorded by the system; this produces surprise, misunderstanding and stress (thus negative evaluations and affects, in addition to misunderstanding) and a “loss of confidence”. The fear here is above all a fear of exceeding the speed limit.

Example 6

Action = “I switch on the system, I’ve pushed on the button (to start up the cruise controller)”

Perception of context = “I was doing 52 km/h according to the speedometer”

Perception of effects = “it put it to 50 and not 52!” ... “I had this impression several times afterwards, always a difference; it shows 107 when I’m driving at 110”

Affects/evaluations = “*it’s bizarre, I don’t understand; it’s astonishing*, I expected that there would be the same thing; I don’t understand”

Two other subjects state, with respect to the same event:

- “I am not respecting the highway code since I am above (the allowed speed) so it *stresses* me”

- “For me it is not right; I *don’t trust* it in matters of legislation, lack of security is another thing; I put that in order to get some peace and I find out that I’m above the speed limit; if you have to have your eyes glued to this system all the time, that means a *loss of confidence* in it.”

We have seen with these examples three sources of distrust and the indicators of this distrust in the discourse of the users expressing negative affects and evaluations, disappointed expectations and misunderstandings of the system.

3.2.2A more exploratory use by groups 2 and 3

3.2.2.1 Qualitative analysis of the exploratory behavior

It is interesting to point out that one can find more exploratory behaviour in groups 2 and 3, who have benefited from a use-oriented presentation, than in group 1, which had read the standard user manual. Previously, we asked the question as to whether the general lowering of confidence after the presentations of the system, would inhibit use or not; we shall therefore see here some elements of responses to this question. Two examples of exploratory behaviour are presented below, with (in italic) the linguistic indicators that allow us to identify exploratory behaviour. We shall see that in addition, the situations explored by the subjects G2 and G3 are quite specific functions, which are rarely used by the complete set of subjects (like the advised speed recall function).

In the following, a subject describes how he explores the speed recall (R) function in order to see how the vehicle will accelerate automatically to attain the requested speed. This function is only explored by one subject of group 1, whereas it is used often (two or three times) by all the subjects of groups 2 and 3.

Example 7 / Group 2

Action/test = “*I did it a little bit on purpose* to press on the button again (R, the advised speed recall) although I was not yet up to 110, *to see* how it would get there (up to 110)”

Perception effect = “I had felt it accelerate all by itself, not an incredible acceleration, but from the sensation of feeling it going, to see myself approaching other cars... you don’t control your acceleration; I felt myself a bit pulled forward”

Affect = “it feels strange; for the moment, it didn’t make me feel too stressed”

The following subject (ex.8) was trying to use a function that did not exist in the tested prototype: when he was in over-speed, and thus the cruise controller remains activated on a lower speed, he can increase his requested speed with the “+” button, or lower it with the “-” button; what he is trying to do here is to press on the R button to memorise his current speed as the advised speed, which is not possible, although it might be an interesting function. One thus observes a creative exploration in the case of this subject of group 3, which presupposes that he felt sufficiently confident with the rest of the manipulations. More generally, this function for recalling a pre-selected speed is not used by the subjects of group 1.

Example 8 / Group 3

Action/hypothesis = “there *I tried something*, it’s that since I’m in over-speed, if I press on the R button, it will perhaps change the advised speed, rather than pressing on + or -, and put me in the speed I’m presently in”

Effect = “and in the end, it doesn’t work”

Evaluation = “so I say to myself that it would have been good if ... accelerating the regulation without using the + or - buttons because 2 kph on each time, I find that a bit slow”

The subjects of groups G2 and G3, to whom the system had been presented with difficult situations of use (in a written or film form) thus explored to a greater extent the possibilities and limits of the system. We have not observed such behaviour in G1.

3.2.2.2 Quantitative analysis of a function use

The video were also analysed to precise the behaviour relative to the exploratory use by the three groups of subjects. Apart from the basic functions, some functions are more complex and more rarely used by the drivers. That is the case of (1) the function “Resume” (R control) to recall the target speed, which is one of the two procedures for reactivating the system after a suspension: resuming the previous target speed with R control or setting a new target speed (using the + control). A study of Brouwer & Hoedemaeker (2004) shows that beginners tend to have difficulties in understanding the specificity of the R function (compared to the + control) ; another study conducted by Renault (Pagot & Rabardel 2008) on the use of the Cruise control system by beginners, intermediary users and experts, indicates that beginners use it very rarely compared to intermediary and experts users. From these results we can state that the Resume function is complex and difficult to master.

On the video of the real situation of driving, we quantified the number of occurrences of the use of this Resume function.

Use of the function “Resume”:

G1 : 2 occurrences by 2 subjects

G2 : 13 occurrences by 3 subjects

G3 : 10 occurrences by 3 subjects

We observe very few occurrences of the use of the R function by subjects of the group 1 (basic paper instruction) compared to the groups 2 and 3. There is then a direct effect of the use-oriented instructions on the exploration of a complex function like the Resume one. Such a difference between the groups is not observed for the reactivation function with the (+).

3.2.3 Distorting reconstructions for groups 1 and 2

One observes more distorting reconstructions of the functioning of the system in groups 1 and 2, contrary to group 3. From this one can infer that the representations constructed after having watched the film are clearer than those that are elaborated after having read the written instructions. In group 3, subjects possibly pose questions on elements that they do not understand, or have doubts concerning certain reactions of the system, but do not go as far as constructing representations that distort the reality of the system.

In the following extract, a user notices that the red band that indicates over-speed lights up, and remarks that the regulator has deactivated itself (following braking about which he is not aware, but which can be observed on the video). On the spot, he creates a rule which consists in thinking that the regulator deactivates itself when the advised speed is exceeded by 5 kph, which is erroneous. More generally, involuntary over-speed (on a slope, and not by depression of the accelerator pedal) is very badly understood by the G1 subjects, who do not associate it with the slope, whereas for G2 and G3 subjects, it is well understood but badly accepted. This example also indicates the lack of understanding and the surprise that are due to slight breaking, that is automatic and not always easy to bring into consciousness, which provokes deactivation of the regulator for security reasons. This hitherto unexplained deactivation can give rise to distrust, where reliability and efficiency of the system are called into question.

Example 9 / Group 1

Perception context + affect = “the red band surprised me, the fact that it lit up”

Perception context/effect = “the regulator disconnected itself, I got back the mobility of the accelerator; I went over it by 5 kph (the advised speed); I’m not responsible for it”

Question = “I don’t think I hit the brake at all; isn’t it surely after 5 kph that the regulator is triggered?”

Below (ex.10), the driver (a woman) of G2 thought she had read that if one brakes and disconnects the regulator, it subsequently reactivates itself when one accelerates. Although use indicates to her that her representation is erroneous, and she attributes this to the fact that she always reads superficially. This example is interesting since it indicates that for certain subjects, who have a tendency of only getting a quick overview of their user manuals, the film presentation, that forces subjects to see everything, would be more appropriate. In this case, the reader had created a rule of functioning that did not exist; this is thus a case of a distorting reconstruction.

Example 10 / Group 2

Intention = “what mattered to me at the beginning was to know how you disconnected and switched it on”

Affect = “because I’m not very confident in the system in fact, that didn’t reassure me much”

Action + evaluation = “I had re-read the instruction manual; I said to myself it’s fine, I’ve understood”

Reflexion/memory = “I thought I had read that in re-accelerating normally it switched itself on again, it seems to me that I read that, after having braked, in re-accelerating, it put itself back to the (requested) speed; the problem is that I always read fast and superficially, always too fast”

Action = “I tried two to three times”

Evaluation = “it did not work; so it was then that I understood that I had understood nothing at all”.

3.2.4 A differentiated level of understanding of the system

At the end of the self-confrontation interview, the subjects were asked orally to quickly recapitulate knowledge about the functioning of the system. Differences between groups were also found on this level, which indicates that the G3 subjects (having seen the film of projection into use) have a more complete understanding of the system.

Certain questions did not discriminate between the groups, these being the most simple ones, those that could only give rise to a very limited number of responses (for example, Q5: how does one know that one is in over-ride?). Conversely, other question that could generate more diversified responses (such as Q4: how do you come back to the previous settings? or Q6: how does one know that the regulator is in/active?) led to more complete responses with the subjects of group 2, and above all with those of group 3.

For example, with the two previously mentioned questions, only the subjects of group 3 made reference to the required condition of minimum speed (30 kph in order to activate the regulator) or described the relevant set of indicators for distinguishing states (which could go as far as description of very precise indicators, such as the hardness of the pedal or the behaviour of the vehicle).

Finally, to the question Q8 (Have you other questions on the use or the functioning of the regulator?) one can distinguish two types of questions: those relative to the functioning of the system, and those, at a higher level, relative to design choices. The subjects of group 3 posed questions that did not seem to be on the same level as the others. They did not bear on questions relating to understanding the functioning of the system, but rather related more to questions on the design choices (e.g. Why doesn't it brake? Why doesn't it start up again after an acceleration? Why can't you input the requested speed in over-ride?).

Finally, more generally, the dissymmetry of functioning between acceleration and deceleration posed numerous problems for these drivers during the discovery phase, and generated difficulties in anticipation and understanding, and therefore mistrust⁷. Even if such dissymmetry is justified for reasons of security, it remains no less true that there is a radical gap between it with respect to the spontaneous expectations of users concerning the functioning of the system. Another cause of disappointment comes from the domain of restricted utility with respect to what is spontaneously expected and wanted. Whilst the subjects had very well perceived the point, with respect to security, of disconnecting the system when they hit the brake pedal, the repeated necessity of re-starting the system in situations of quite dense traffic ended up by being too tedious to justify the use of the system in these situations.

As we insisted above, the states of the system can, in a more or less prolonged way, be outside the field of consciousness of the driver. We have seen this for braking in order to make small adjustments to speed, and for over-speeds that are not decided on the drivers' initiative (slopes). Given that light braking is a brief and automatic action, it escapes from conscious awareness; in the same way, drivers are not always aware of the fact that they are going downhill.

The consequences of breaking, which is in the state of deactivation of the system, are thus frequently neglected by drivers. From this, a frequent discrepancy results, between the state expected of the system (being always in regulation) and its real state (disconnection), which contributes on one hand to stimulating numerous questions on the state of the system and its causes, and, on the other hand, to

⁷ e.g. the brake interrupts the regulation but not the acceleration, successive pressing on the (+) key produces acceleration whereas this same action on the (-) key does not act upon the brakes, the (+) key allows to enter into cruise control from the current speed, but not with the (-) key.

requiring a repeated need (that is perceived as detrimental) for visual control on the display. These sources of discomfort do not help to create confidence in the system.

4. Discussion

From the point of view of the user, leaving a system to regulate the speed of his own vehicle requires delegating a part of control over an essential function of driving, which is not without risk for the driver. In man-machine, as in inter-human interactions, trust is an affective feeling, linked to appraisal of reliability and predictability, that is indispensable for accepting to depend upon another, whether human or machine, without emotional discomfort. This emotional comfort is central for accepting to use an assistance system (Cahour 2008) and if one distrust the system he/she will feel uncomfortable.

Here we focussed on (dis)trust towards a cruise control system, and on the tranquillity of subjects with respect to the fact that the system is not going to put them into dangerous situations (danger of having an accident, of being outside the law, of behaving in a non-civic manner). We studied here the confidence in the system but it must be emphasised that self-confidence is an equally important element in this relation towards automation, and that an experienced driver would without doubt be more rapidly feel confident with the system than a more generally cautious or timid driver would; certain authors also distinguish the confidence that is felt *in the relation* towards the system. Nevertheless, it seems to us to be difficult to distinguish these different elements from each other in the verbal protocols, as well as using measurement scales, especially in a first trial of the system. What people describe is more of the order of the interaction that they entertain with an aspect of the system, then a mix of the three types of confidence: I do not totally master and anticipate the functioning of the system (self-confidence), and so I do not trust it (trust in the system) and I do not trust the use that I can put it to (trust in the relation), each of the three being intimately intertwined with the others.

The objective of this experiment was to experiment a new type of accompaniment for initial use of an assistance for driving, with as a general hypothesis that projection into use based on a film support would allow trust in the system to be improved, as well as greater exploration during the first trying out of the system, together with better understanding of the functions of the system at the end of the first use of it.

Our results indicate that the presentation of instructions (whether in the form of a film or otherwise) lowers the evaluation of trust (and of efficiency) that conductors have a priori, which indicates that, on the basis of little information, they construct a representation of a cruise control system that is rather idealistic, and realise, after reading of the instructions, and above all after having watched a film, that its use is not so obvious as they had previously thought. There is thenceforth a drop in trust that nevertheless goes up again after use of the system during driving. The same thing happens with evaluation of efficiency of the system for regulating speed, whereas reliability and predictability do not evolve significantly. We remark nevertheless, from qualitative analyses of use of the regulator in real driving conditions, and from the lived experience of this use by subjects, that this drop in trust in the system does not inhibit subjects in their use, and in particular, for subjects who have watched a film of projection into use. They explore (subjects of the G2 group) more of the functions of the system in driving conditions, they invent less than groups 1 and 2 ways functioning of the system that do not exist (distorted reconstructions), and they have a deeper level of understanding of the system. However, we have remarked inter-individual differences, and our exploratory study should be developed further with a larger number of subjects.

We conclude that instructions have an important role in warning subjects, which is a bit more disappointing than what they imagined, and that the showing of the film of projection into use provides a more complete contextual support which prevents the superficial reading we had observed with certain subjects, and which lends itself less to imagination and reconstruction of the context; in effect, with the film the visual dimension is not reconstructed mentally, but is well rendered objectively on the screen. One could say that the space for imagination is less with watching a film

than it is in reading a text. Also with the film, the subject can project himself in the situation of use and, even if this is a less efficient training than the effective use recommended by Sarter & al (1997), it gets nearer to the use, and it is more realistic with such a general public product.

(Dis)trust must be considered as a feeling that is in constant evolution, and, supposing that the distinction between a priori trust (type 1) and trust constructed by experience (type 2) is relevant, it must be possible to refine this categorisation since we can see here the differences constructed between trust of type 1 (a priori - by hearsay, essentially) and trust of type 2 (after more complete presentation of the system). In the distinction between the two, the quantity of information that the subject has available is of course at stake, which is very superficial in the first case, and quite complete in the second, with a continuum between the two. Likewise for type 2 trust, concerning which we have only explored the initial familiarisation with, and use of the system; thus the question of the evolution of this use, of learning and appropriation that can unfold subsequently, is obviously raised. In this case also there are sub-categories of type 2 trust, that are distinguished from each other according to the duration of the experience of use. The fact that we were not able to explore this evolving aspect of use is of course a limitation of our work. Yet we justify this focus on initial use by the fact that drivers seem to be capable of becoming discouraged after a first use, and from then onwards never activate their systems, even if they keep them available to themselves. It is thus essential to record what happens during the first moments of use.

In this study we focussed on negative aspects (these being greater priorities within the objectives of an ergonomic evaluation-design of the system), but it must be emphasised that several positive aspects of the cruise control system were also expressed by the subjects, notably the comfort of its use on roads that are relatively flat without much traffic (such as motorways) where they did not have to worry about controlling their speed. Once the driver has understood the favourable contexts of use and some particularities of the system, the limits of the system seem more reduced than the limits of the human ability. Without the system, the driver needs to have very frequent visual checks, which are costly, for controlling the speed of his vehicle. In general, the functions of the cruise control systems are appreciated, especially with the reinforcement of the speed regulation. A study performed within the European project AIDE (Lheureux & al, 2004) indicates that seventy percent of the owners of a cruise control system state that they regularly use the system (associated or not to the use of a speed limiter), and twenty percent use none. It is then largely used and perceived as an advantage in some conditions, especially since the legislation on speed limitation has been reinforced.

Finally, this work insists on the fact that for research in ergonomics that is concerned with evaluation and design of systems, it is important to take the lived experience of users into account, together with its affective dimensions (feelings of trust but also diverse emotions) which provide us with information on the relationship that subjects maintain with certain precise elements of the system, and on their desires to use it, together with the degree of emotional comfort that they experience in so doing. We have shown here how (dis)trust is linked to expectations and misunderstandings of subjects, as well as how it is expressed by emotions and diverse feelings. These subjective aspects of the activity can only be studied within a clinical perspective with the subjects verbalizing their experience of use. The subjective scales only give us an idea of the global trust but not of the origins of this trust/distrust in the situation of use, which is the main point of interest for designing or re-designing appropriate tools.

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Figure 1

Diagram of temporal sequencing of data collection:

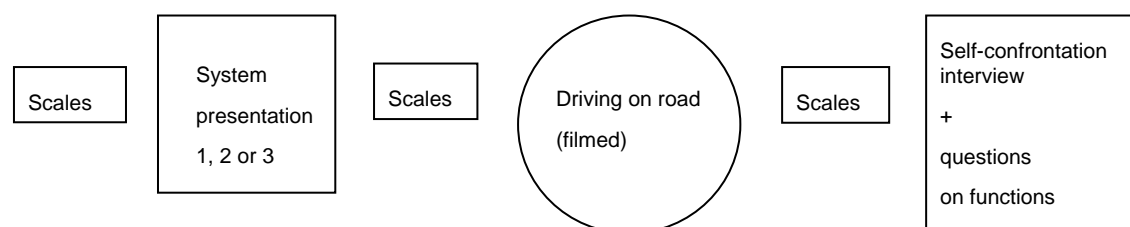


Table 1

Comparative statistics (t of Student of paired groups)

Scales headings	T1		T2		T3	
	Average	S.D.	Average	S.D.	Average	S.D.
E1 : Trust	83,8	16,1	72,6	24,6	85,5	9,7
E2 : Reliability	70,9	21,5	82,1	11,0	77,3	21,4
E3 : Predictability	79,1	15,2	76,7	16,3	75,6	21,1
E4 : Efficiency	91,5	6,9	83,7	7,3	77,8	16,1

Scales headings	Comparison T1 –T2	Comparison T2 –T3	Comparison T1 –T3
E1 : Trust	p=0,049	p=0,048	N.S.
E2 : Reliability	N.S.	N.S.	N.S.
E3 : Predictability	N.S.	N.S.	N.S.
E4 : Efficiency	N.S.	N.S.	p=0,024

Figure 2

Evolution of the *trust* averages according to the presentation

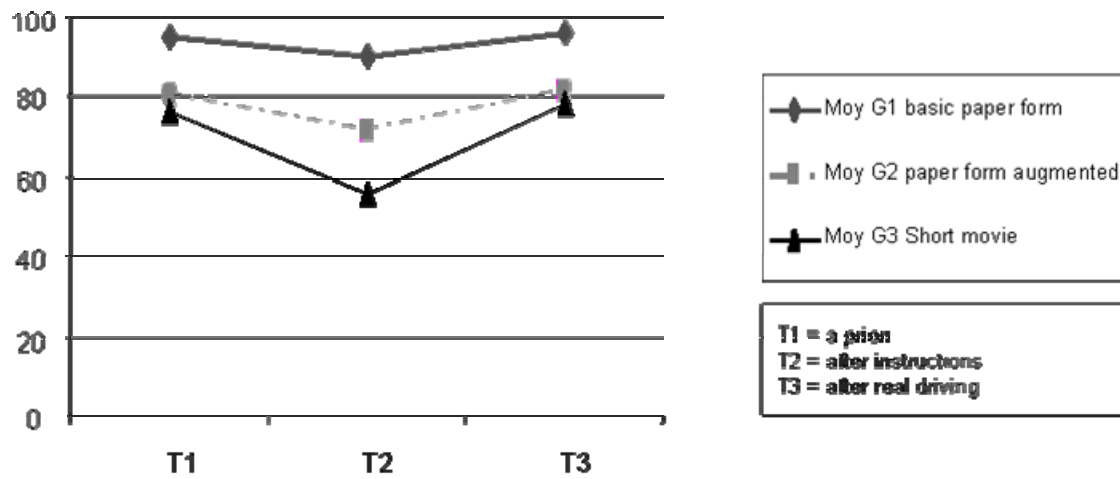


Figure 3

Evolution of the feeling of the system *efficiency* averages according to the presentation

