

HUMAN FACTORS:

HUMAN ERROR AND SELF-CONTROL TECHNIQUES.

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ABSTRACT

This work aims to show the usefulness of self-control techniques for the prevention of unintentional errors caused by skill-based actions. The basis of this proposal lies in the ability of language to regulate behavior and how this can be put into practice to prevent errors that could cause major accidents.

keywords: Self-instructions, Self-control techniques, Language, human error, attention, critical situations, safety.

INTRODUCTION

In this work, starting from theories of human error (Reason, 1990 and Rasmussen, 1979) and from neuropsychology on modes of thought and the social origin of higher psychological functions (Luria 1961, Vygotsky 1977), we intend to describe the possibilities that self-control techniques may have for the prevention and reduction of errors caused by skill-based behaviors (SB).

Our thesis is that an inadequate balance between the use of intuitive or fast thinking (System 1) and slow or analytical thinking (System 2) is at the root of these skill errors and that, at the same time, self-control techniques may be useful techniques for their prevention.¹

To glimpse the potential of this thesis it will be necessary for us to know, first of all, the nature of human error.

1. The nature of human error

Starting from the conceptual framework provided by Professor James Reason *The Generic Error Modeling System*,² we can understand the nature of error and the

¹ Kahneman, D., *Pensar rápido, pensar despacio*, Debate, Trad. Joaquín Chamorro. 2014 p. 22

² This theory tells us among other things, that the term error is not enough to explain all the ways in which the human being can contribute to the production of an accident and for this reason it also includes the term infractions or violations. Cf. Reason, J., *The Human Error*, Modus Laborandi, 2009. Trans. José Ángel Sisqués

mechanisms of its production, which will undoubtedly help us to understand the role that the techniques we propose here can play in its prevention.

This model provides a classification of the different types of error that can be committed according to their intentionality and relates them to the different types of possible action (according to Rasmussen's model). The three basic types of errors it identifies (Slips and Lapses, Rule-based Mistakes and Knowledge-based Mistakes) are related to the different types of action and level of intentionality provided by Professor Rasmussen's model (skill-based action, rule-based action and knowledge-based action).³ In this way, the model tells us that errors related to skill-based actions would be involuntary, such as slips and lapses, which are the ones we are going to deal with in this work.

1.1.Unintentional acts.

The description of this type of acts that are at the basis of the errors by skills will allow us to understand the way in which self-control can help us. According to Rasmussen, each type of behavior is related to a certain way of perceiving the environment, which in the case of unintentional acts would be in the form of signals, space-time, that would activate highly integrated behavior patterns, after a wide exposure of the person to these signals, to trigger an automated behavior. These types of acts are related to actions that take place without conscious control.⁴

Some authors consider that the occurrence of unintentional errors is related to the interference of specific triggers in cognitive processes, in situations in which these should be deactivated but in fact are not. These triggers would cause action to be controlled by fast or intuitive thinking rather than slow or analytical thinking.⁵

System 1 thinking is the one that acts as usual when there are no complications; generally, our System 2 gives credence to its impressions and is only mobilized when System 1 encounters some difficulty. This division of cognitive work between System 1 and System 2 works well most of the time, however, the issue is that System 1 cannot switch off and is prone to make systematic errors in specific circumstances.⁶ Failure to adequately resolve this conflict between an automatic reaction and the intention to control behavior is common in our lives and is often the source of absurd decisions that can lead to both error and maladaptive behavior.

To overcome these System 1 traps, we would have to take control of our behavior and thus challenge our impressions, but since we cannot adopt as a rule of life this continuous vigilance of our System 1, what we could do would be to reach the compromise of learning to recognize situations in which errors are highly probable and try to avoid them by using System 2. An initial proposal of this strategy would be to always use a conscious-analytical type of thinking when we perform critical tasks, which would be determined by manual or degraded situations, in which the system would depend mostly on us, and

³ Rasmussen, J., "Skills, rules, Knowledge: signals, signs and symbols and other distinctions in human performance models", *IEEE Transactions: Systems, Man, Cybernetics*, SMC-13, 257-267(1983)

⁴ Rasmussen, J., Skills, Rules and knowledge; signals, signs, and symbols, and others distinctions in human performance models, *IEEE Transactions on systems, man and cybernetics*, vol. smc., 13, No 3, May 1983.

⁵ Cf. Morel, C., *The absurd decisions*, Modus Laborandi, Madrid, 2009. Trad. Celia Recarey. P.124

⁶ Nobel Prize winner Daniel Kahneman devoted part of his work to describing, with ingenious experiments, these traps, biases or systematic errors that are at the root of absurd decisions. Among these biases would be the Anchor effect or the Priming effect that he describes in his book. Cf. Kahneman, D., *think fast, think slow*, op. Cit. P. 26

the consequences of our actions would be very serious. It would be enough to use a matrix like the one in Illustration 1 to catalog the criticality of actions.

consequences	high				high priority	
	medium					medium priority
	low					low priority
		low	medium	high		
	level of human intervention					

Table 1 example of simple criticality/prioritization tables and matrices

Another of the theses of this work is that working on self-control through stimulus control techniques and self-instructions can be an appropriate strategy to inhibit automatic thinking in situations that would require analytical thinking (S 2). One of the keys to achieve this objective lies in the control of attention that these techniques can exert, since, as we have seen previously when discussing involuntary acts, this type of errors would be related to attentional problems.

The value of stimuli control techniques and self-instructions as modulators of the types of attention would rest on the function of language to control behavior and attention.⁷

A large part of human cognitions could be considered automatic thoughts or chains of highly internalized responses that, on many occasions, can lead us to error. The way to avoid this type of erroneous decisions would be in the de-automatization of behavior that could be achieved with the self-control provided by language.

2. THE ROLE OF LANGUAGE IN THE REGULATION OF BEHAVIOR.

In order to understand our proposal on the techniques of self-control, it is necessary first to deal with the arguments that recognize language as a source of control of behavior and attention.

The role of language in the formation of higher psychological processes has to do with the specifically human capacity to develop a system of signs that serves, according to the work of Vygotsky and Luria, both for the self-control of behavior and, in the cognitive domain, for the planning of difficult tasks and, in our opinion, also for the inhibition of automatic thoughts involved in involuntary errors.

Different authors have attributed to language a determining role in the formation of higher cognitive processes and in the self-regulation of one's own behavior. According to Vygotsky's theory on the cultural development of psychological processes, language

⁷ There are many examples within the transportation industry where the use of thinking 1 or quick thinking instead of thinking 2 or analytical thinking has led to errors with serious consequences. Cf. Morel, C., *Las decisiones absurdas*, Modus Laborandi, Madrid, 2009. Trans. Celia Recarey

would have the capacity to serve the self-control of behavior and, at the cognitive level, the planning of solutions to difficult tasks.⁸ Vygotsky based his ideas on the analysis of the concrete activity of children, coming to determine the functional properties of inner language. He observed that when he confronted children with some complex tasks and some difficulty arose in its realization, the children began to talk, even if no one was present, the child's monologue at first described the difficulty, and then expressed the possible plan to get out of the situation."⁹

This egocentric language was first a simple companion of the child's action, but he observed that it progressively became an instrument of thought dedicated to the planning of cognitive and affective tasks, to tasks of self-reflection on one's own behavior, and to decision making.

Luria, following Vygotsky's interpretation of inner language, studied the regulatory function of language (Luria, 1984), discovering that the first form of self-regulation of the child's behavior would have its origin in the orientation provided by the adult's language, although in this first form of regulation it is observed that behavior is still easily altered by the immediate visual impression produced by the objects in the environment (the effect of involuntary attention) and it is only when this social language becomes a private language that the child can self-regulate his behavior without being influenced by the elements of the environment; that is, by inhibiting involuntary attention.

In this way, language, whose destiny is to internalize, and guide thought and behavior, helps the child to elaborate a plan with respect to the activity he performs, helps him to mental orientation and conscious understanding, that is to say, it plays an important role in the mastery of one's own behavior and consciousness. On the other hand, this language does not disappear throughout our lives, but changes from external social to internal private, which allows us to deepen the value of language as a regulating element of thought also in adults.

Luria considers that with the use of oral language the perceived environment can be modified, in such a way that it can have the functionality of inhibiting voluntary motor behaviors.¹⁰ Language becomes a mediator that can change the way of perceiving the environment instead of as signals, which activate highly integrated behavior patterns in the individual, as signs or symbols that would put into operation what the executive theory of intelligence (TEI) understands as the properly human cognitive functions, such as self-control or inhibition of impulses, attention management, emotion management, choice of objectives, etc., which would collaborate with the purpose of achieving autonomy of action.¹¹

Language thus becomes the necessary tool to achieve that the control of behavior passes from an external stimulus to the subject himself, because it can achieve the inhibition of impulse, the direction of attention, the management of motivation and emotions, the choice of goals and the maintenance of effort, all of them functions of System 2 of

⁸ Vygotsky, L., *History of the development of higher psychic functions. Selected works. Volume III. Visor. Madrid (1995)*

⁹ Leonor. A., The role of inner language in the regulation of behavior, Mérida, *Educere*, Vol.3, pp 61-68 (2000).

¹⁰ Miranda Casa, A., y Santa Maria, M., *Hiperactivity and learning difficulties*, book promotion, Valencia, 1986, p.

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¹¹ CF. Marina. J.A., Pellicer, C., *The intelligence that learns*, Ed. Santillana, Madrid, 2015.

thought. The question we come to then is, how can language be used to improve our attention and make S2 work in critical situations? For this we can use self-control techniques.

2.1. Self-control techniques.

Self-control is the capacity to direct one's own psychic processes in accordance with chosen goals. It is the quality that differentiates human intelligence from animal intelligence, and it is a quality that is acquired through training. The conclusion is that the way of behaving will depend on the capacity for self-control, which makes this ability an important element in the prevention of error due to involuntary acts.

The failure in self-control would be at the basis of many of the problems that happen to us in daily life, both those related to our health, with the development of addictive behaviors or aggressiveness, as well as those related to our efficiency and the production of errors. The importance of these effects makes self-control the cornerstone of intelligent behavior, that is, behavior that achieves its intended goals. Animal behavior is stimulus-driven, but human beings have two stimulus systems: a sensory one and a linguistic one that provides the capacity to direct the whole gigantic brain mechanism towards goals chosen by ourselves, which invites us to think that language can be a good tool to prevent the error of acts that have their basis in automatic thinking and attentional problems.

In the field of clinical psychology, self-control has to do with the participation and involvement of the subject in the change required by the therapeutic process proposed by the specialist. The requirement that a behavior must meet for us to be able to speak of self-control is that it is set in motion without any external physical or social instigation, and it is based on the idea <<*to know yourself is to know the variables that control you*>> (Thoresen and Mahoney, 1974)¹²

We use the label self-control in reference to those actions that have to do with the initiation of a controlling behavior that is going to try to alter the probability of occurrence of another conflicting behavior that we are going to call controlled. This has to do with the triggering of an automatic behavior that we want to control when we are performing a complex action. For example, when we are driving on an icy road for the first time and when we lose control of the car we automatically step on the brake. To avoid stepping on the brake (controlled behavior) we would need to develop an alternative controlling behavior, such as downshifting, that prevents its occurrence.

To understand the possibilities of self-control, it should be noted that unintentional errors are based on an intuitive and semi-unconscious type of thinking, which is activated by environmental signals, such as when we lose control of the car on a road that only rarely, during the winter, freezes and triggers in us the need to step on the brakes. This environment would be characterized by a series of spatial signals (loss of control) that would activate strongly established or automated behavioral patterns, such as stepping on the brake, which would not be very adaptive. The way to avoid this type of error would be either using stimulus control techniques or through the individual's ability to inhibit

¹² CF. Labrador, J., Cruzado, J.A., Muñoz, M., *Manual of behavior modification techniques and behavior therapy*, Edicions Pirámide, Madrid, 1993, p. 580.

this type of intuitive thinking in favor of analytical or scientific thinking.¹³ Language can play an important role in both strategies.

2.1.1. Stimulus control techniques:

1.- Change of stimuli: We are referring to change the way of understanding the information coming from the environment, instead of as signals, activators of intuitive thinking, as signs or symbols, activators of analytical or scientific thinking, through the mediation of language. The success of this change lies in the different belonging of signals, signs, and symbols to different domains of reality. While light or sound signals, would belong to the world of the physical and would elicit sensory-motor responses, signs and symbols would belong to the world of ideas and would elicit logical responses. In the case of driving on an icy road, the perception of tire skidding as a spatial signal of loss of control of the car leads us to step on the brakes, whereas if we perceive the skidding of the car as a sign of the properties of the ice, perhaps the action could be aimed at reducing a gear to try to regain adherence. In the railway environment in which we operate, if we analyze the case of a traffic controller faced with a degraded situation, in which the automatic blocking system does not work, the visual signals representing trains or traffic light signals could be complemented with written messages, which would appear in the videographic in the form of a dialogue to alert of the degradation of the system; activating the system 2 thinking and the executive functions of thinking.

The key to inhibit the automatic response would be to create an option in the video graphic, with which the movement of trains is managed, that would allow replacing the normal configuration by a degraded mode in which the information received would not be in the form of visual or acoustic signals, with the capacity to elicit automatic responses, but in the form of signs or symbols (text or images) that would provoke the participation of the executive functions of intelligence.

2.- Change of the social environment: With this technique we are referring to the introduction of a person in the context in which the behavior occurs so that his presence prevents the automatic response. In the case of a control center operator facing a degraded situation in a rail traffic control center, the presence of the traffic regulator or a co-worker would influence the person in charge of the affected regulation band not to act with the autopilot engaged.

2.1.2. Self-instructions.

What interests us about self-instructions lies in the ability of language to control behavior through its capacity to activate conscious forms of knowledge. As we have been arguing, the type of thinking employed, System 1 or System 2, to direct behavior is responsible for the involuntary errors we are going to deal with.¹⁴ Our view is that these errors are caused by the implementation, by an external agent, of rudimentary cognitive bricolage or intuitive thinking, at a time that would require type 2 or conscious thinking. Self-instructions will be that technique that will allow us to inhibit this type of thinking that is triggered automatically causing errors.¹⁵

¹³ Cf. Morel, C., *The absurd decisions*, Modus Laborandi, Madrid, 2009. Trad. Celia Recarey. P. 124

¹⁴ Cf. Kahneman, D., Think fast, think slow, *American Psychologist*, Vol. 34 (1984)

¹⁵ Cf. Morel, C., *The absurd decisions*, ed. Modus Laborandi, Madrid, p.38

But how can self-instructional training help us to achieve this goal? Before answering this question, we should briefly summarize what self-instructions are.

Also called self-verbalizations, self-instructions constitute a system that allows us to "talk to ourselves", and which in turn provides a series of guidelines that guide us and help us to solve tasks autonomously.

Donald Meichenbaum (Meichenbaum, 1977) defines self-instructions as a continuous series of statements to ourselves in which we tell ourselves what to think and believe, and even how to behave. Through this internal monologue, based on concrete thoughts that we can control, we influence our thoughts, feelings and behaviors. It is, therefore, a technique of verbal self-regulation of behavior.¹⁶

"To change a given routine of actions or thoughts requires the positive intervention of the attentional control mode. The omission of this intervention in moments of concern or distraction is the most frequent cause of slips in action..." (Reason, 1979).

TRAINING SELF-INSTRUCTIONS METHODOLOGY

Our proposal would be as follows:

1. **Detection of critical situations for which it is imperative that the system 2 is activated.** Organizations should determine which activities should be proceeded in such a way as to ensure that they are not done routinely (system 1), avoiding a possible incorrect execution and a subsequent operational problem. For example, in the railway field, this type of activities may be related to degraded or manual situations, in which the automatic locking systems do not work. Also, critical situations with serious consequences would be the performance of work on the track, in which many testing activities are required to ensure safety (Prior to the work: installation of protection systems - shunt bar, stop signals, whistle sign, speed reduction. During the work: permanent communication with all those involved. After the work - checking the removal of equipment, people, and trains, returning the track to normal conditions with limitations, putting all equipment back into operation).

Once it has been determined which activities are critical the next step would be to assess them.

2. Assess the critical situation according to taxonomy.

It is probable that not all situations can or should be transferred to a text. For this reason, it might be convenient to classify them according to their consequences and the level of human intervention required:

¹⁶ CF. Meichenbaum, D., *Cognitive Behavior Modification: An integrative Approach*, Plenum Press. New York. 1977

- Low priority: green, they would probably not require a read aloud of any procedure, although they could be kept under observation.
- Medium priority: orange, would require at least a "know" out loud once a procedure has been heard.
- High priority: red, indicated for situations where the risk is significant, and the requirement would be to read aloud all the steps to be followed.

3. Determine the message what should be said out loud and how to do it.

Indicating in the same Table 1 example of simple criticality/prioritization tables and matrices, the type of "reading" to be performed would be as follows:

consequences	high	“Known”	Reading Aloud	Reading Aloud	high priority	
	medium	not required	“Known”	Reading Aloud		medium priority
	low	not required	not required	“Known”		low priority
		low	medium	high		
	Human intervention level					

Once we have assessed whether the message should be read aloud, we should consider that there are two ways to proceed with this type of action:

1. **Known:** orange color. The message will be heard by the employee, who will acknowledge its completion. This type of message is usually used when making a check list when taking and leaving an installation or when checking equipment and machines. The procedure should be divided into different paragraphs according to operations, and not cover different operations in the same report.
2. **Reading aloud:** red color. The message will be spoken aloud by the employee. It can be read directly from a procedure or by repeating a pre-established audio recording (in case he/she cannot take his/her eyes off the activity he/she is performing, for example, driving a vehicle).

In both types 1 and 2, the messages heard should end in some kind of audible signal that indicates that the employee should start repeating the sentence or acknowledge the message.

4. Proceed to read it or speak it aloud.

- Directly read the procedure (Procedure in hand).

- Include voice recognition system in the software (it is very easy for compliance with this obligation to decline over time). These voice recognition systems could be "interlocked" with the hardware being used, whether setting itineraries at a circulation post, or driving a track vehicle.

5. Assessment and Reinforcement of behaviors:

- Positive reinforcement when new behaviors achieve desired responses.