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Emotion Regulation and Goal-Directedness

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RESUMEN

Una caracterización popular de la regulación emocional afirma que esta es un proceso de segundo orden diferente de la emoción y orientado a la meta de modificarla de alguna manera. La separación entre emoción y regulación emocional ha sido cuestionada a partir del hecho de que las emociones pueden regularse a sí mismas por medio de mecanismos de retroalimentación. Sin embargo, la relevancia de estos contraejemplos es dudosa. La retroalimentación emocional es diferente de casos paradigmáticos de regulación en que frecuentemente aquella no involucra la representación de una meta. Emplearé un enfoque cibernético de la orientación a metas para mostrar que la representación de una meta no es necesaria para la regulación. Adicionalmente, el enfoque implica que la autoregulación es un aspecto constitutivo de la orientación a metas de las emociones mismas. Así, la retroalimentación emocional no es sólo un caso genuino de regulación, sino también un aspecto constitutivo de las emociones.

PALABRAS CLAVE: *emoción, orientación a meta, regulación, cibernética.*

ABSTRACT

A popular approach to emotion regulation is that this is a second-order process which is different from emotion and which is driven by the goal of modifying it in some way. The separation between emotion and emotion regulation has been challenged by the fact that emotion regulates itself through different feedback loops. However, the relevance of these counter-examples is doubtful. Emotional feedback is different from standard instances of regulation in that it often involves no representation of a goal. I will employ a cybernetic approach to goal-directedness in order to show that goal representation is not necessary for regulation. Additionally, the view implies that regulation is a constitutive aspect of the goal-directedness of emotions themselves. Thus, it is not only the case that emotional feedback is a genuine type of regulation but it is also a constitutive aspect of emotion.

KEY WORDS: *Emotion, Goal-directedness, Regulation, Cybernetics.*

I. INTRODUCTION

The study of emotion regulation is a relatively recent but thriving field of research in which a great variety of psychological disciplines are

involved. Significant progress has been made in understanding emotion regulation in the cognitive, neural, behavioral, developmental and social domains [Gross (2014)]. However, the main concept that defines the area is difficult to characterize. Although there is some consensus regarding the characterization of specific kinds of processes that regulate emotion, there are still discussions around the general notion of emotion regulation. Gross has proposed an approach according to which regulative processes are reflective or second-order processes that operate on emotions and, therefore, are different from them [e.g. Gross & Thompson (2007) and Gross (2008)]. This ontological separation between emotion and regulation is relevant because it implies that emotion regulation research is not simply a sub-field of emotion studies but it rather focuses on a different (although related) kind of process which (to some degree) can be studied on its own.

Against this approach, Kappas (2011) argued that emotions always regulate themselves through different kinds of feedback loops. His argument implies that one cannot study emotions without studying emotion regulation. However, the relevance of these counter-examples is doubtful. There are important differences between emotional feedback and paradigmatic instances of emotion regulation. For example, emotion regulation is a goal-directed process aimed at modifying some aspect of emotion. In contrast, emotional feedback often involves no representation of its goal. In this paper, I will explore a particular characterization of goal-directedness and examine its implications for the relation between emotion and emotion regulation. Specifically, I will argue that a cybernetic approach to goal-directedness can be used to show that these two processes are conceptually related.

In section II, I present the 'second-order' approach to emotion regulation. In section III, I describe some examples of emotional feedback and explain why they may fail as counter-examples to the second-order view. Emotional feedback (for instance, as it occurs in habituation and satiety) is often a process that is not driven by the representation of a goal and therefore does not seem not to be goal-directed, as standard regulatory processes are. In section IV, I argue that a cybernetic approach to goal-directedness can be employed to show that goal representation is not necessary for regulation and that the negative feedback exhibited by habituation and satiety is sufficient. Additionally, this view implies that emotional feedback is constitutive of the goal-directedness of emotions themselves. Thus, the cybernetic framework suggests that emo-

tional feedback is a genuine instance of regulation and that it is also a constitutive aspect of emotion.

II. Emotion Regulation As Second-Order Valuation

The clarification of 'Emotion Regulation' requires offering some characterization of both 'Emotion' and 'Regulation'. As we will see, these two notions are closely related in Gross' 'second-order' proposal. Gross [e.g., Gross (2007), (2014), (2015)] mentions four core components of an emotion prototype. These constitute a sequence of related sub-events: (1) The presence of a relevant (often external) situation causes a subject to (2) pay attention to some aspects of that situation. Then, (3) the subject evaluates those attended aspects with respect to her goals. Finally, this evaluation causes (4) a series of changes in experiential, behavioral, and neurobiological response systems. Any motivational state which satisfies most of these 4 conditions counts as an emotion.

A classification of emotion regulation strategies naturally emerges from this characterization of emotion episodes. Gross (2015) affirms that different kinds of emotion regulation can be understood as interventions on different components of emotion. Situation selection is the set of actions that make it more (or less) likely that one will have an encounter with the emotional stimulus. We apply this strategy, for instance, when we avoid attending to an annoying family reunion. Situation modification is the set of actions that modify the situation which contains (or does not contain) the relevant stimulus in order to reduce (or enhance) its emotional impact. We apply this strategy, for instance, when we ask a friend to support us while we face a stressing or sad situation.

Attentional deployment is the strategy of directing attention towards or away from emotionally meaningful aspects within a given situation in order to enhance or inhibit the emotional response. When we avoid making eye contact with someone we are attracted to (or scared of, or both) in order to diminish the emotional response, we employ this strategy. Cognitive change is the strategy of modifying our emotions by changing the way one appraises a situation. For instance, one can regulate the fear elicited by the encounter with a scary-looking animal by thinking that the animal is probably not dangerous or by considering that we are able to defend ourselves from it. Lastly, response modulation is directly influencing experiential, behavioral, or physiological components of the emotional response. This includes a wide variety of strategies. One can employ different drugs that target specific somatic aspects of the emotional response. For in-

stance, we can take anxiolytics to reduce muscle tension or beta-blockers to reduce sympathetic hyper-reactivity. Deep breathing relaxation or physical exercise can also be used as forms of response modulation. Another common form of response modulation involves regulating emotion expressive behavior [Gross, Richards, and John (2006)].

Although characterizing interventions on different aspects of emotion is relevant to distinguishing between different regulatory strategies, this is not sufficient to understand what emotion regulation is. We need to specify how these variables are modified. Gross (2015) provides a more detailed model of emotion regulation. This is what he calls 'The Extended Process Model of Emotion Regulation'. Gross' proposal is that emotion regulation is a valuation process. This process involves different components. The first two components are a situation in the world and the perception of that situation. The third component is a valuation or appraisal of the perceived situation. More specifically, Gross characterizes a valuation as a juxtaposition of a representation of the world with a representation of a desired state of the world (a goal or target state). Finally, an action component is constituted by the actions or action impulses caused by a valuation, which are supposed to reduce the gap between the perceived and the desired state of the world. Emotion regulation occurs when a valuation mechanism or system evaluates (either negatively or positively) a state s_1 of some component C of an emotion, activating action impulses that are intended to modify or sustain s_1 within the parameters determined by the representation of a target state s_2.

As Gross points out, the valuation process has the same components as emotion: situation, perception/attention, appraisal and response. This means that emotions are valuations in this sense. This is why emotion regulation can be seen as a second-order valuation. It is a valuation process that targets a component of another valuation process. As I mentioned, this proposal implies that emotion and its regulation are two different (although causally related) processes. This means that emotion regulation studies are not merely a sub-field of emotion research but they rather focus on a different phenomenon. However, the process of emotional feedback seems to undermine this view. I will examine different instances of feedback in the next section.

III. EMOTIONAL FEEDBACK

It is patent that many common types of emotion regulation are reflexive or second-order cognitive processes. For instance, when we feel

fear in the presence of a non-threatening insect, we may realize that this emotion is ridiculous (i.e., form a conscious negative evaluation of the emotion) and decide to be brave and overcome it (by using deep-breathing, thinking about something else, etc.). However, Kappas (2011) points out that many forms of emotion regulation do not require any process that is different from the emotion itself. For instance, negative emotions are self-terminating events. When a given stimulus (e.g., a spider) elicits a negative emotion (e.g., fear), the emotion produces a behavior (e.g., killing the spider, running away, etc.) that is oriented to suppress in some way the presence of the eliciting stimulus and, consequently, the emotion itself. Kappas affirms that all negative emotions are self-terminating in this sense and that this involves some kind of regulation.[1]

These processes are inconsistent with Gross' view because they imply that regulation does not require any additional process that is different from emotion. According to the very emotion prototype proposed by Gross, the behavioral response that produces the elimination of the emotion-eliciting stimulus (and therefore the termination of emotion) is a constitutive part of the emotion episode. The physiological, experiential and *behavioral* responses produced by a valuation constitute the fourth component of the emotion process. This means that, *pace* Gross, these regulatory processes are not different from the emotion itself.

Based on an argument proposed by Gross and Barret (2011), Gross (2014) affirms there are many different ways to define an emotion, each of which suggests a different take on how (and whether) emotion and emotion regulation should be distinguished. Gross and Barret (2011) argue that basic emotion approaches (in which emotions are determined by well-defined biological mechanisms) and appraisal theories (in which emotions are defined by a specific set of evaluations) are consistent with a clear distinction between emotion and emotion regulation. In contrast, in psychological and social constructionist approaches, which view emotion as the result of individual or social cognitive processes, the distinction between emotion generation and emotion regulation seems arbitrary or artificial.

The problem with this response is that there are forms of emotional feedback [also mentioned by Kappas (2011)] which are implemented by purely biological mechanisms that do not involve any form of social of psychological construct. This is the case of satiety and habituation. Kappas argues that satiety implies that positive emotions can also be self-terminating events. Briefly, satiety is a form of self-termination that positive emotions possess. This is the mechanism that explains why we are not trapped in the positive feedback loops of positive emotional

states. These states are constituted by an appetitive activity which is terminated by a consummatory response [see Georgiadis and Kortekaas (2010)]. It is known that this control process is performed by purely neural and hormonal mechanisms ('wanting/reward' or 'pleasure/liking' mechanisms) [e.g., Berridge (2009)]. In turn, habituation is a form of feedback regulation that both positive and negative emotions have. When a stimulus is presented repeatedly or continually (without significant changes) habituation will produce a reduction of its physiological and psychological responses. It has been shown that, at least in some species, habituation depends on the mechanism of synaptic short-term depression [Mazur (2017), pp. 44, 45]. These examples show that emotional feedback can occur in processes that do not involve any social or psychological construct and therefore the identification between emotion and emotion regulation does not depend on our characterization of emotion.

One could object that these examples are not instances of emotion regulation because the regulated processes are not genuine emotions. It is clear that this objection does not apply to habituation, which modulates paradigmatic emotions such as fear [see Mazur (2017), p. 41]. In contrast, satiety is involved in the regulation of states such as sex drive or hunger, which may not be typical emotional states. Gross sometimes distinguishes emotions from these motivational states in that the former are more flexible and have a broader range of potential targets [Gross and Thomspon (2007), p. 7]. The problem with this response is that it is not obvious that these motivational states are not emotions. In the first place, we saw that flexibility and broad target range are not part of the emotion prototype proposed by Gross himself. If this prototype is representative of how we understand (or should understand) emotions, it seems that the notion should also be applied to the mentioned motivational states. More importantly, there are relevant basic emotion proposals that include hunger and sex drive as genuine emotions.

For instance, Bradley and colleagues developed a motivational model of emotion [e.g., Bradley et al. (2001a) and Bradley et al. (2001b)]. According to this view, the different emotions are the effects of two motivational systems that have evolved to deal with situations that either promote or threaten physical survival. A defense system is activated in contexts involving threat and is responsible for the basic behavioral responses of withdrawal, escape, and attack. In turn, an appetitive system is activated in contexts that promote survival, including sustenance, procreation, and nurturance and is responsible for the behavioral responses of *ingestion*, *copulation*, and caregiving. This implies that it is at least con-

troversial to say that sex drive and hunger are not emotions. Therefore, a defense of the second-order approach cannot simply assume this.[2]

Another strategy against Kappas' objection is to affirm that there are aspects which are constitutive of regulation and are not possessed by emotional feedback. Gross (2014) mentions three core features of emotion regulation. The first one is the activation of a goal to modify the emotion-generative process. The idea is that regulation involves some kind of motivation or purpose. For instance, subjects are often motivated to decrease negative emotional states and increase positive emotional states [Larsen (2000)]. Also, they are usually motivated to decrease positive emotions and increase negative emotions [Parrott (1993)]. Gross (2014) points out that this motivation can be explicit or implicit. Emotion regulation can be either explicit, conscious, effortful, and controlled or implicit, unconscious, effortless, and automatic [Gyurak and Etkin (2014); Gyurak, Gross, and Etkin (2011)]. The second core feature is that this motivation initiates a process which alters the emotion trajectory. These different processes are the regulatory strategies mentioned in the previous section (i.e., situation modification, attentional deployment, cognitive change and response modulation). The third core feature of emotion regulation is its impact on emotion dynamics [Thompson (1990)], or the latency, rise time, magnitude, duration, and offset of responses in experiential, behavioral, or physiological domains.

Goal-directedness plays a crucial role in regulatory processes. A process which has an impact on emotion dynamics but is not goal-directed towards this effect is not a regulatory process in any plausible reading of 'regulation'. For instance, suppose that a fear response is triggered in a subject *S* by a spider that suddenly appears in her environment. Suppose further that *S*'s response is suppressed by the fact that a passer-by accidentally steps on the spider. It seems that, despite its impact on *S*'s emotion, we should not consider this accidental event as an instance of regulation. Likewise, if *S*'s fear is modulated by anxiolytics that, unbeknown to her, were contained in a bottled drink she bought at a store, we would be reluctant to affirm that *S* regulates her emotional response. Regulation requires some kind of purpose.

Feedback processes are not always inconsistent with the notion of purpose suggested by Gross' first condition for regulation (i.e., the idea that purpose involves the explicit representation of a goal). A feedback system is often constituted by a 'plant' (the object to be controlled), a sensor to measure the output of the plant and a controller to generate the plant's input. The output signal is compared to a desired reference

signal and the discrepancy is used to compute corrective control action [e.g., Doyle et al. (1992), pp. 1, 27]. Regulation as it is implemented by feedback processes often depends on the representation of a goal by a reference signal. If emotional feedback is implemented by mechanisms of this kind, then it can be considered regulatory in Gross' sense.

However, feedback in satiety and habituation does not involve any implicit or explicit representation of a goal but is rather fully characterized by the dynamic interaction between purely biochemical variables. It is known that satiety depends on hormonal and/or neural modulation. For instance, female and male appetitive and consummatory sexual behavior is regulated, in part, by androgens and estrogens [e.g., Balthazart et al. (1995), Everitt (1990)]. The effect of androgens depends on an intracellular mechanism involving the androgen receptor (AR), which functions as transcription factor to regulate the expression of target genes. In some species, male sexual satiety after copulation depends on a reduction of AR expression in limbic brain areas that control endocrine function (which in turn depends on circulating levels of androgens). For our purposes, the important fact is that the reduction of AR and, consequently, sexual satiety is caused by one or various ejaculations (i.e., sexual consummatory behavior). This characterization of sexual satiety implies that the consummatory behavior modulates sexual motivation without the mediation of any representation of an achieved goal but rather through the interaction of purely biochemical variables.

Food satiety is similar to sexual satiety in this respect. Many studies have indicated that neuropeptide Y (NPY) stimulates and leptin inhibits appetitive and consummatory food-related behavior [e.g., Ammar et al. (2002), Keen-Rhinehart et al. (2013)]. Leptin is expressed by adipocytes and the concentrations of leptin in adipose tissue and plasma parallel the mass of adipose tissue, which in turn are correlated with food intake. Leptin is released into the circulatory system by the adipose tissue as a function of the energy stores. Once released, Leptin decreases the inhibitory tone of γ-aminobutyric acid (GABA) released from NPY terminals in the arcuate nucleus, hyperpolarizing NPY neurons. In rodents and in humans, this results in a decrease in food intake and an increase in energy expenditure [Ahima and Antwi (2008)]. The function of this process is to maintain the size of the body fat stores [Klok et al. (2007)]. This means that food satiety is also produced by a chemical effect directly produced by the consummatory behavior (food intake) and not by the representation of this achieved goal.

It has been shown that, at least in some species, habituation to sensory stimuli depends on the synaptic short-term depression of early sensory neurons. Synaptic depression occurs when sustained signaling between two neurons diminishes the ability of pre-synaptic activity to generate post-synaptic activity. Some studies indicate that in some species (and regarding specific stimuli), habituation is produced by a decreased emission of calcium ions into the axon terminals in sensory neurons after repeated stimulation. This makes sensory neurons less effective to trigger the motor neurons which produce the normal behavioral response [e.g. Abbott and Kandel (2012); Castellucci, Pinsker, Kupfermann, and Kandel (1970), Davis, Gendelman, Tischler and Gendelman, (1982), Condon and Weinberger (1991)]. This implies that habituation does not require the mediation of any representation but is rather the result of a biochemical modification of the early neural response to a stimulus. In order to provide a notion of regulation that can be applied to forms of biological feedback such as satiety and habituation we need a characterization of goal-directedness that does not require representations. In the next section, I will suggest the goal-directedness of regulatory processes can be understood in terms of a cybernetic approach.

IV. A CYBERNETIC APPROACH TO EMOTION REGULATION

There are good reasons to reject a proposal that identifies goal-directed behavior with behavior produced by the representation of a goal. There are many systems which seem intuitively goal-directed but plausibly lack (sophisticated) representational capacities. Such notion would not apply to the behavior of creatures such as plants or insects. Although it is controversial whether these organisms exhibit intelligent behavior [e.g., see Cvrčková, Lipavská and Žárský (2009)], it seems reasonable to attribute them goal-directed behavior. This representational notion would neither apply to machines such as homing torpedoes, which seem to be goal-directed in some sense.

A tradition for thinking about goal-directedness in non-representational terms was inspired by the development of cybernetics and the manufacture of "servomechanisms" during World War II [Wiener (1948)]. In pioneering papers, Sommerhoff (1950) and Rosenblueth et al. (1943) developed a concept of purposiveness that could apply to machines as well as organisms, and that did not appeal to (conscious or unconscious) intentions or representations. Adopting Trestman's terminology, this would constitute a form of 'implicit goal-directedness' [Trestman (2012)]. This

expression is not equivalent to Gross' idea of 'implicit regulation'. Unlike Trestman's, Gross characterization of 'implicitness' has no implications regarding the relation between regulation and representation. Gyurak, Gross, and Etkin define explicit emotion regulation as a process that requires conscious effort for initiation, demands monitoring during implementation, and involves some degree of insight and awareness. In contrast, implicit regulation is evoked automatically by the stimulus itself, runs to completion without monitoring and can happen without insight and awareness [Gyurak, Gross and Etkin (2011)]. This characterization is neutral regarding whether regulation requires representations. Automatic, unaware and non-monitored regulation may or may not require goal representation.

In turn, 'implicit goal-directedness' refers to a particular characterization of the relation between goal-directedness and the representation of a goal. The representation of a goal might be part of what causes and explains some goal-directed behaviors. Furthermore, there could be a reliable correlation between goal representation and goal-directed behavior. Based on this correlation it could be possible to postulate a goal representation on the basis of this kind of behavior. However, the idea behind the cybernetic approach is that representation *is not a constitutive aspect* of goal-directedness. The question about whether a given behavior is goal-directed is independent of the question about what representations (if any) cause or explain that behavior.[3] A relevant intuition shared by authors in this tradition is that goal-directedness can be defined in terms of a characteristic kind of behavior. Specifically, goal-directed systems exhibit persistence and plasticity [e.g., Nagel (1977), p. 272 and Ashby (1960), pp. 54, 55].[4]

For instance, a heat-seeking missile is persistent in closing in on a moving target because it tends toward this goal in the face of obstacles (e.g., if the target moves or if the missile gets moved, then it will adjust its trajectory). The missile also exhibits plasticity because it can achieve the same end (i.e., hitting its target) through a variety of different starting points. There is wide range of points from which the missile can be launched, and it will still result in the same outcome [Garson (2016)].

Sommerhoff (1950) proposed that the systems which exhibit this kind of behavior have 'directive correlation'. This means that a system's behavior produces the same outcome in a variety of possible situations because it is modified in order to be correlated or 'matched' with the relevant environmental conditions. The concept was central to his research program in neuroscience and biocybernetics [Sommerhoff (1950), (1974)]. The idea behind this characterization can be understood by using his ex-

ample of a chicken pecking at a grain [Sommerhoff (1974), p. 18]. The chicken modifies its pecking behavior in different situations in order to track the location of the grain. When the grain is moved, the peck's location is corrected in order to match the grain's location. In contrast, a mechanical 'chicken' just bobs up and down irrespective of the grain's location. Moving slightly the grain in any direction would prevent the pseudo-chicken's bob to hit the grain.

This analysis has been criticized on different grounds. The objection that is more relevant for our discussion is what Garson (2016) calls 'the problem of overbreadth'. This is simply the problem that the criterion cannot distinguish goal-directed systems from those that intuitively lack goal-directedness. A marble rolling to the bottom of a glass bowl or a stretched rubber band snapping back to its original configuration are not goal-directed but nonetheless exhibit plasticity (they can reach the same end point from a variety of starting points) and persistence (they can adjust their trajectory in the face of obstacles).

This problem is relevant because it could be argued that a more restrictive notion of goal-directedness requires the representation of a goal. However, there are different ways to reformulate the approach in non-representational terms. For instance, Rosenbleuth et al. (1943) proposed that goal-directed systems are governed by negative feedback mechanisms. Goal-directed behavior is persistent and flexible behavior achieved through negative feedback. The fact that negative feedback systems exhibit plasticity and persistence can be seen (informally) by considering a paradigmatic feedback system such as a thermostat. If the environmental temperature moves away from a target value, a thermostat will adjust its behavior in order to return it to that state. Also, a thermostat can reach the desired temperature from different starting points. This view is also able to exclude the mentioned instances of spurious goal-directedness because rubber bands or marble balls do not possess the internal organization required for negative feedback. Although this view has also faced some objections [see Garson (2016) for a review] it is plausible that additional (and non-representational) conditions can be added in order to meet them, as is suggested by more contemporary defenses of the cybernetic approach [e.g., Trestman (2012) and McShea (2013)].

Even after accepting that feedback is sufficient for goal-directedness, one could wonder whether goal representation is necessary for feedback.[5] We saw in the previous section that feedback often involves a reference signal that represents the desired state of a system, which is used to compute a discrepancy with its actual output. I also mentioned that the cases

of satiety and habituation imply that negative feedback does not necessarily require this kind of internal computational organization but can often be fully characterized by the interaction of purely physical variables. However, one may ask whether these processes can (or should) still be characterized as computational and representational.

In order to show the limits of a representational approach to this kind of feedback system, Garson (2003) proposed comparison between a 'symbolic' and a 'non-symbolic' thermostat. The symbolic thermostat uses sensors in order to collect temperature information about the environment and converts this information into a string of symbols which are stored in a memory M of a small computer. This computer includes a program involving instructions such as such as 'if the number in M is smaller than 20 then turn on the furnace burner'. On the other hand, a non-symbolic thermostat connects the furnace to a bimetallic strip in such a way that as air temperature falls, the strip bends, thereby opening a valve that sends more fuel to the furnace's burner.

It would be inappropriate to characterize the non-symbolic thermostat by using the computational model, since no computation over data representing the world is performed. One can fully understand and explain the behavior of this furnace, for instance, by using differential equations that describe the interaction between the purely physical variables for room temperature and valve position (as in a dynamical model). More importantly, the computational view is not applicable here because, as Garson (2003) points out, "we lack any meaningful distinction between the data and the procedures that operate on the data". The representational view, as it is applied in cognitive science, requires distinguishing between the representations of a system and the computational operations by which the system manipulates its representations. Although one might claim that the amount of bend in the bimetallic strip carries information about (or even represents) the temperature of the room (any reliable correlation produces some information), this variable is a part of the mechanism that directly ensures that room temperature and valve opening interact in the right way. There is no additional process or program that operates over this information in order to produce this outcome and therefore there is no reason to appeal to a representational/computational framework. This example shows that it is possible to achieve persistence and flexibility (i.e. goal-directedness) through negative feedback without also requiring goal representations or internal representations at all.

This view is consistent with Gross' proposal because, as I mentioned, the main reason to include goal-directedness as a condition for

regulation is to exclude purely accidental processes (such as the passer-by accidentally stepping on a spider). This is accomplished by the cybernetic approach because it characterizes goal-directed processes as those that produce the same result in a wide range of alternative situations (and therefore the result is not accidental). Persistence and plasticity are two ways of being robust in the production of a given effect.

Also, this approach to goal-directedness has important implications regarding the relation between emotion and emotion regulation. In the first place, the fact that processes such as habituation and satiety do not involve the representation of a goal does not imply that they fail to satisfy Gross' first condition for emotion regulation. Recall that Gross (2014) affirms that emotion regulation must be goal-directed but can be implicit. If we understand 'implicit goal-directedness' in Trestman's cybernetic sense, then goal representation is not necessary for goal-directedness. Moreover, these processes plausibly satisfy the conditions for being goal-directed. All of the examples mentioned by Kappas (i.e., not only habituation and satiety but also the self-termination of negative emotions) are instances of negative feedback-control. We saw that this kind of causal/functional organization is sufficient for the kind of plasticity and persistent behavior that constitutes goal-directedness.

Prima facie, these considerations seem to favor Gross' view. They show that emotional feedback is not problematic because it can be characterized as an instance of regulation in his sense. However, we saw that a crucial aspect of his proposal is that emotion and emotion regulation are different kinds of processes which can be studied (to some degree) apart from each other and therefore emotion regulation constitutes a relatively autonomous field of research. Accepting that emotional feedback is a form of emotion regulation implies that regulation is part of what emotions do. Thus, we cannot provide a complete characterization of emotions without characterizing emotion regulation.

It could be objected that although regulation is something that emotions do, it is not a constitutive aspect of them. Perhaps emotion and regulation can be at least conceptually distinguished and this could be sufficient in order to claim that regulation is a distinct phenomenon which can be studied on its own. However, the cybernetic approach implies that there is a tight conceptual relation between emotion and its regulation. Under this view, it is not merely the case that the regulatory aspect of emotion is goal-directed but rather it *constitutes the goal-directedness of emotion*. We saw that, according to the cybernetic view, goal-directedness is flexible and persistent behavior achieved through negative feedback. That is, negative feedback

is necessary for goal-directedness. This means that emotions are goal-directed processes only because they regulate themselves via negative feedback. Gross accepts that goal-directedness is a constitutive aspect of emotion [Gross (2014), p. 4]. If this is so, a cybernetic approach to goal-directedness implies that regulation cannot be conceptually isolated from emotion.

An additional (and related) possible objection could be that emotion and emotion regulation have *different* goals. While the target of emotion regulation is modifying some aspect of the emotion process, emotion is directed towards external goals, that is, it is aimed at modifying (or maintaining) some aspect of the external environment. For instance, one could consider that although fear can modify itself, this is not its goal. Perhaps the goal of fear-driven behavior is eliminating (or being safe from) an external threat. If having an inward-directed goal is necessary for being an instance of emotion regulation, then it seems that emotions fail to qualify as regulatory. The problem with this objection is that relevant regulatory strategies studied by emotion regulation studies have outward-looking goals. For instance, we saw that situation modification and situation selection are aimed at changing relevant environmental features. This means that inward-directed goals are not necessary for emotion regulation.

One could reply that in situation selection and modification, changing the environment is only a means of modifying the emotion itself, which is the real goal. That is, these outward-looking strategies have an ultimate inward-looking goal. However, once we accept that internal representations are not required to identify goal-directedness behavior there is no ground for distinguishing between the feedback loop of negative emotions and situation selection or modification. From a purely behavioral standpoint, when fear of spiders causes in a subject the behavior of killing a given spider (which in turn causes the elimination of fear), this is simply an instance of situation modification (that is, modifying environmental features in order to modulate the emotion process). The goal in emotional feedback is as internal or external as in any other instance of situation modification and selection. Therefore, either emotions have internal goals or these are not necessary for emotion regulation.

To summarize, I have argued that the debate on the distinction between emotion and emotion regulation can be addressed by appealing to re a tradition that characterizes goal-directed behavior in non-representational terms. Accepting the reasonable assumption that goal-directedness is a necessary condition for emotion regulation, this view implies that emotional feedback is a genuine form of regulation and therefore studying emotion

regulation is part of studying emotion themselves. I further argued that regulation is not merely something that emotions do but rather a constitutive aspect of them. This is because, according to the cybernetic approach, regulation is necessary for the goal-directedness that emotions exhibit.

V. Conclusion

I claimed that it is not clear whether the forms of emotional feedback mentioned by Kappas (such as satiety and habituation) are problematic for the distinction between emotion and regulation because these do not involve the representation of a goal. Satiety and habituation can be characterized by the interaction of purely biochemical internal variables. Given that goal-directedness is a constitutive aspect of regulation, if goal representation was necessary for goal-directedness, emotional feedback would not be regulatory.

I argued that a cybernetic approach can be used to show that goal representation is not necessary for goal-directedness and that emotional feedback is regulatory. Satiety and habituation are implemented by feedback control mechanisms, which exhibit persistence and plasticity. These are the features that, according to the cybernetic view, constitute goal-directedness. Furthermore, this proposal implies that regulation is a constitutive aspect of emotion. Emotions are goal-directed only because they regulate themselves though negative feedback. Assuming that goal-directedness is a constitutive aspect of emotion, emotions are necessarily self-regulatory. This means that emotion regulation research focusses on a phenomenon that cannot be conceptually isolated from emotion. This thriving field is not dedicated to understand a completely new phenomenon but rather a new aspect of a known phenomenon.

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Notes

[1] However, as an anonymous referee has pointed out, there may be exceptions such as nostalgia.

[2] I thank an anonymous reviewer for suggesting that I should address the nature of these motivational states.

[3] I thank an anonymous referee for pointing out that I should clarify the notion of implicit regulation (and goal-directedness) underlying the main arguments.

[4] I am indebted to an anonymous referee for highlighting the aspects of the cybernetic approach that are relevant for the present debate.

[5] I am indebted to an anonymous referee for suggesting this possible objection.

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