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Social Media Platforms: Trading with Prediction Error Minimization for Your Attention

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ABSTRACT

Culture exploits the acquisition of meaningful content by crafting regimes of shared attention, determining what is relevant, valuable, and salient. Culture changes the field of relevant social affordances worthy of being acted upon in a context-sensitive manner. When relevant affordances are highly weighted, their attentional capture and their salience increase the probability of them being enacted due to the associated expectation for minimizing prediction error. This process is known as active inference. In the digital era, individuals need to infer the action-related attributes of digital cues, here characterized as digital affordances. The digital affordances of digital social platforms are of particular interest here. Digital social affordances are defined as online possibilities of social interactions. By their own nature, these are salient because they are related to social interactions and relevant social cues. However, the problem of digital social platforms is that they are not equivalent to situated social interactions because their structure is built, mediated, and defined by third-parties with diverse interests. The third-parties behind the digital social platforms are using the same mechanism exploited by culture to manipulate the shared patterns of attention. Moreover, digital social platforms are deliberately designed to be hyper-stimulating, making digital social affordances highly rewarding and increasingly salient. This appropriation, for economic purposes, is an issue of great importance, especially as the COVID-19 pandemic brought deep global changes, pushing societies to an online digital way of life. Here, we examined different types of digital social affordances under an active inference view, placing them into two categories, those for self-identity formation, and those for belief-updating. This paper aims to analyze digital social affordances in light of the prediction error dynamics they might elicit to their users. Although each of the analyzed digital social affordances allows different epistemic and instrumental digital actions, they all share the characteristic of having an "easy" and a fast expected rate of error reduction. Here, we aim to provide a new hypothesis about how the design behind digital social affordances is built on our natural attractiveness to minimize prediction error and the resulting positive embodied feelings when doing so. Finally, it is suggested that because digital social affordances are becoming highly weighted in the field of affordances, this might be putting at risk our context-sensitive grip on a rich, dynamic and varied field of relevant affordances.

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Keywords active inference; digital affordances ; · patterns of attention ; · prediction error minimization ; prediction error dynamics

1 Introduction

Through development, individuals learn cultural knowledge, passed on through generations, and upheld by their niche. The selective patterning of salience and attention, based on the cultural knowledge about what is relevant in a given situation, is one of the core underlying process behind enculturation [Clément and Kaufmann, 2007, Veissière et al., 2020]. These processes vary according to the culture, shaping differential patterns of attention [Kitayama et al., 2003, Masuda and Nisbett, 2001, Swallow and Wang, 2020, Masuda and Nisbett, 2006]. Thus, the 'content' of cultural knowledge is full of norms, preferences, consistent and relevant to others in the cultural group or community [Veissière et al., 2019]. In fact, it has been proposed that the nature of human culture is to guarantee that specific well-bounded and highly valuable sates are frequented, facilitating the avoidance of states of surprise [Veissière et al., 2020]. The free-energy principle (FEP) formulates how any biological system resists the tendency to disorder by minimizing its free energy or the surprise associated with sensations (i.e. prediction error) [Friston et al., 2012a]. Under the FEP, prediction error minimization is by itself the drive to maintain individuals in their preferred states as an existential imperative. In this regard, it has been suggested that cultural shared patterns of attention and shared expectations reduce metabolic costs to minimize prediction error [Ramstead et al., 2016]. Additionally, the concerns of individuals immersed in a culture are shaped by learning socio-cultural practices, which determine what stands out as relevant in the field of affordances in a situated moment (i.e. relevant possibilities of action) [Rietveld, 2012, Bruineberg and Rietveld, 2014]. According to the FEP, by means of active inference, expected future states are fulfilled through action execution and the associated expected prediction error is minimized by actively sampling sensory information. In general, active inference can be characterized as the process of selecting relevant affordances, those which are expected to minimize prediction error in a context sensitive-manner [Kiverstein et al., 2021].

Nowadays, individuals are immersed in both a geographically situated culture and in a digital culture [Ash et al., 2018]. Together, they determine the patterns of attention that will be learned and the affordances that will show-up as relevant in a given moment. Even before the year 2021, digital tools were developing at an exceptional speed [Edosomwan et al., 2011]. However, the coronavirus (COVID-19) pandemic brought deep global changes that pushed schools, workplaces, and social communities to an online mode in order to avoid almost any face-to-face interaction Wiederhold [2020]. Given the importance that the online way of life has taken worldwide, digital affordances (i.e. online possibilities of action) have become an enormous part of our landscape of affordances [Henningsson et al., 2021]. The worldwide average time spent engaged in digital affordances is seven hours, representing almost the half of the total sixteen waking day hours [Annie, 2021]. The field of digital affordances includes abundant digital social affordances, which are those possibilities of online social interactions particular to the attributes of a digital social platform [Carr et al., 2016].

Digital social platforms, and their related digital social affordances can be compared to off-line media. An important difference being that the latter worked across longer periods of time. In general, media affords 'life writing' to build a self-identity, to chronicle periods of life (e.g. photographs, albums, diaries), and to represent our interactions and relationships with others [Humphreys, 2018, Poletti and Rak, 2014]. Digital social affordances share similarities with offline social affordances (i.e. geographically situated possibilities of social interactions), but they are different in the way they shape identities and affect our interactions, having the power to represent reality in new ways [boyd, 2011]. Importantly, digital social platforms are mediated by third-parties with economic and political interests Grön and Nelimarkka [2020]. The 'datafied times' we are now living in determine the design behind digital social platforms, which aim to increase the time users spend on digital social platforms in order to keep them producing more and more data, because data is what generates value [Barassi, 2020]. The developers behind digital social platforms maximize the time users spend on the screen by amplifying what attracts their attention [Harris, 2017-04]. Additionally, digital social platforms are built with the aid of learning algorithms, fed by the data that users produce, to predict users' behavior and preferences [Arrieta-Ibarra et al., 2018-05]. Thus, by means of the use of learning algorithms, salient and relevant information is presented to each user with the aim to increase the probability of maintaining their engagement with the digital social platform and generate more value.

Digital social platforms function as a hyper-affordance in such a way that the field of digital affordances become more and more salient as the digital interactions increase Karahanna et al. [2018]. Digital social platforms operate by exploiting how attention is manipulated by culture through shared patterns of attention for marketing purposes. The 'economy of attention' is a key component of the information society we are immersed in, which is based on developing strategies to control the time and attention of users to generate more data and more value [Giraldo-Luque and Fernández-Rovira, 2021]. In this regard, here, a theoretical explanation of the mechanism behind the attentional manipulation of digital social affordances is formulated based on prediction error minimization under the active inference framework. Our main hypothesis relies on the users monitoring of the prediction error dynamics, the rate at which prediction error is

minimized over time, during the engagement with digital social affordances in digital social platforms. The experienced embodied feelings with a positive or a negative valence, are the key component of how the sensitivity to the rate of error reduction is manifested as changes on affect [Carver and Scheier, 1990, Miller et al., 2020a]. We want to highlight that the task of minimizing prediction error and obtaining positive valenced error reduction rate, becomes *easier* when engaged in digital social affordances in comparison to geographically situated affordances. As an "easy" and fast rate of error reduction occurs, digital social platforms obtain and keep the users attention. Although digital social platforms provide many different types of digital social affordances, here, we analyzed some common ones placing them into two categories: self-identity formation and belief-updating digital social affordances. These categories were created based on their effects that the rate of prediction error reduction, as well as their associated expected rate of error reduction, have on users' beliefs about themselves, and about others and the world, respectively.

Particularly, the analysis is focused on how a context-sensitive grip on a rich, dynamic and varied field of relevant affordances is changing, as well as the ability to distinguish what is relevant, valuable, real or fake in the face-to-face offline situated world. The relevance and the salience of affordances change depending on a particular situation happening on a specific time, as well as if the context and individuals' concerns change [De Haan et al., 2013]. If specific affordances become extremely salient, they can create an imbalance, and indeed a collapse, in the field of affordances [Miller et al., 2020a]. This imbalance is an imminent risk, given that the field of digital social affordances is becoming more and more salient as attentional manipulation increases for the benefit of third-parties economic interests. Here, we suggest that the narrowing of the context-sensitive field of relevant affordances is occurring towards a biased anticipatory digital social affordance-responsiveness.

2 The Free energy principle

The distinguishing characteristic of biological systems is the need to maintain their states in the face of environmental perturbations resisting a tendency to disorder Friston [2012]. The free-energy principle (FEP) is a mathematical formulation of how any biological system resists the tendency to disorder by minimizing its free energy. The repertoire of interoceptive and exteroceptive states an organism can be in is limited by its phenotype. It is possible to say that there is a high probability that the organism will be in those limited sensory states and a low probability to experience any other state not related to its phenotype. Free energy, roughly speaking, is equivalent to prediction error or the surprise associated with sensations [Friston et al., 2012a]. Henceforth prediction error and prediction error minimization will be used in this paper.

In order to be sensitive to prediction error, an agent needs a generative model of how the sensory data are generated and a recognition density on the parameters of the generative model, the causes of its sensory states [Friston, 2010]. The generative model is a joint probability density between a likelihood describing the probability of sensory information given the environmental state, and a prior or beliefs about the probability over the environmental states [Buckley et al., 2017]. The generative model can be understood as a statistical mapping from the hidden causes of the sensory states to sensory observations [Ramstead et al., 2020]. One of the core hypotheses of the FEP is that the brain uses approximate Bayesian inference, which is analogous to variational Bayes, because it is extremely difficult to calculate a posterior belief using the likelihood and prior with the Bayes theorem [Friston, 2010]. The approximate Bayesian inference approach requires the introduction of an auxiliary probability density, the recognition density. The recognition density is the agent's implicit probabilistic representation of the best guess of what caused the sensory states [Buckley et al., 2017]. The recognition density rests on the inversion of the generative model to recognize the most probable cause of a given observation. When an agent is confronted with an observation the evaluation of how surprised it is considering all its possible states, can only be inferred based on its statistical model of its expected sensory states [Ramstead et al., 2020]. An agent has access to its sensory states, and to a recognition density, which is encoded by its internal states (e.g. neuronal activity) [Friston, 2010]. Prediction error minimization makes the recognition density a suitable approximation to the posterior density. Therefore, under the FEP, prediction error is the quantity that has to be minimized by giving the best approximation of the posterior density [Buckley et al., 2017].

The role of generative models is not to have a true model of the world, instead they model the agent acting in the world in order to control and regulate action to enable survival. We move from a deductive or inductive model to an abductive, best approximation model of the world. It has been suggested that the recognition density can be seen as being embodied in terms of what an agent is, and the generative model as being enacted, what an organism does. The generative model is expressed in the embodied activity of an agent, enacting the expectations that it generates [Ramstead et al., 2020].

2.1 Perceptual and active inference

Prediction error can be minimized by two different but closely related strategies working together, perceptual and active inference Pezzulo et al. [2015]. The generative model provides access to the expected states an agent can be, providing the capability to make relevant predictions regarding those states, as well as to selecting adaptive actions that conform to those predictions Friston and Frith [2015]. Under the FEP, perception involves optimizing predictions by updating prior beliefs about the causes of sensations, and action corresponds to actively changing the sensory samples to fulfill predictions [Friston et al., 2011]. During perception, prediction error is minimized by recursively updating the generative model until predictions match the incoming sensory inputs [Clark, 2015]. This strategy is known as perceptual inference. During perceptual inference, prediction error minimization occurs in the cortical hierarchy by means of top-down predictions anticipating bottom-up incoming sensory inputs. This process allows the optimization of top-down predictions in order to minimize prediction error in lower levels of the cortical hierarchy [Friston, 2010]. Passively minimizing prediction error throughout perceptual inference always leads to belief updating. This occurs when a prior belief is combined with the new evidence to be updated to a posterior belief [Adams et al., 2013]. The change in a prior belief, encoded as a posterior belief, is quantified by the informational gain [Kruglanski et al., 2020], which can be understood as learning. Thus, prediction error is minimized when the surprisal states are assimilated by means of changing the recognition density that encodes the posterior beliefs.

Prediction error can also be minimized by actively sampling sensations that fulfill the expected states that correspond to beliefs about future states of the world and the body [Friston, 2017]. Given that biological agents are the embodied authors of their sensations, they need to infer the consequences of their actions in terms of expected future states [Friston et al., 2017a]. Thus, when the expected future states are fulfilled through action execution, the associated expected prediction error is minimized. This strategy for prediction error minimization is known as active inference. An action can be defined as bringing about a set of observations that change the hidden states in the world. On the contrary, control states, known as policies, are hidden states that are used to explain the consequences of an action and these are inferred in the generative model [Friston et al., 2012a]. Hence, the expected prediction error provides prior beliefs about plausible policies in a given situation. The expected prediction error of a policy is evaluated by the difference between the predicted outcomes and the preferred outcome plus the ambiguity expected under the predicted states of the policy [Friston et al., 2017b]. In general, active inference can be characterized as the process of selecting relevant affordances, those which are expected to minimize prediction error Kiverstein et al. [2019].

2.2 Attention and precision weighting

Belief updating also depends on a set of second-order expectations concerning the reliability of sensory signals, and their corresponding predictions, given the current state of the biological agent in a context [Nave et al., 2020a]. Second-order expectations assign weights to prediction errors, and to their related predictions, as a result of their reliability or precision (inverse variance). Thus, this precision weighting mechanism depends on whether prediction error is expected as precise and relevant, as well as if their related prior belief is assigned with a high or low confidence [Kruglanski et al., 2020]. For example, if a high (low) precision is assigned to an error signal, meaning that the corresponding prior belief has a low (high) confidence, the resulting prediction errors would (not) have a greater influence in belief updating.

Precision weighting, has a crucial role in mediating the salience of cues in the perceptual domain. When precision is encoded, particular prediction errors are enhanced (attenuated) by selectively increasing (decreasing) the weight of incoming sensory information as well as to prior beliefs [Badcock et al., 2017, Friston et al., 2012a]. Under this view, attention entails estimating, in a context-sensitive manner, the precision of sensory signals during perception [Feldman and Friston, 2010]. Computational, neourophysiologic, and anatomic evidence strongly suggest that dopamine has a central role in the encoding of precision, which can be understood as the associated value of prediction error [Friston et al., 2012b]. In general, dopamine has a central role in the capability of predicting any future outcome [Diederen and Fletcher, 2021]. Thus, dopamine seems to be fundamental in modulating the influence of bottom-up sensory information and top-down predictions during perceptual and active inference.

2.3 Instrumental and epistemic actions

Friston et al. [2017a] suggest that expected prediction error can be minimized by choosing three forms of uncertainty resolving policies. First, epistemic information-seeking policies about future states of the world. Second, novel-seeking curious policies that lead to learning the probabilistic contingencies between future states and its outcomes. Novel-seeking curious policies are associated to uncertainty reduction, and the drive behind them is not necessarily related to a specific anticipatory utility [Kobayashi et al., 2019]. Third, goal-seeking pragmatic policies related to specific outcomes or preferences. These three types of policies can be categorized on epistemic and instrumental actions. While instrumental actions are extrinsically motivated goal-directed behaviors that afford a preferred outcome, epistemic

actions are intrinsically motivated learning-directed explorative behaviors that afford novelty or information gain. Although epistemic actions tend to be biased towards seeking positive valenced outcomes, uncertainty reduction is intrinsically valuable by itself regardless of its outcome.

By means of perceptual inference, a biological agent needs to infer the current context in order to choose an uncertainty resolving policy [Friston et al., 2017a]. When a context is ambiguous epistemic actions will dominate until uncertainty is resolved, and as a consequence, instrumental actions, related to particular preferences, tend to predominate [Friston et al., 2017a]. Context learning leads to a faster encoding of hidden states accompanied with dopamine responses encoding precision [Friston et al., 2017b]. Hence, the beliefs about competing policies have higher precision in familiar contexts. This means that becoming familiar with the context increases the confidence about the policies to be enacted and their corresponding rewarding outcome. Under this view, attention is given to actions related to precise beliefs over preferred rewarding outcomes (intrinsic value), and salience is afforded by those actions that potentially lead to information gain (epistemic value) [Parr and Friston, 2017]. Therefore, active inference provides a disambiguation between the terms attention and salience, where attention is understood as the process of precision weighting, and salience as the process of sampling new sensory data for uncertainty reduction [Parr and Friston, 2019].

Expected prediction error prioritizes policies in terms of their expected instrumental and epistemic value in a given context. Policies that are aligned with preferences, by changing sensory inputs in an expected manner, maximize instrumental value, and policies that pursue information gain by changing beliefs in light of new evidence maximize epistemic value [Tschantz et al., 2020, Sajid et al., 2021]. Thus, the minimization of expected prediction error is achieved by selecting appropriate policies depending on the external and internal context of an individual in a given moment. Additionally, as we will discuss in the next section, policy selection and its disengagement also depend on the monitoring of prediction error dynamics over time.

2.4 Prediction error dynamics

A primary way that the predictive system tracks its predictive performance, is through a sensitivity to the rate at which error is being minimized or reduced relative to expectations. Behavioral policies are selected in part based on the expectations of the rate at which prediction error will be reduced overtime. These expectations allow the system to monitor its own performance relative to policy selection (e.g. [Carver and Scheier, 1990]). Changes in the rate of error reduction, sometimes called "prediction error dynamics" [Kiverstein et al., 2019, Van de Cruys, 2017, Clark, 2018], play an important role in tuning precision estimations on policies. If the speed of error reduction is faster that expected, then the action policy should be made more precise.

This sensitivity to changes in the rate of error reduction is now believed to be delivered to the organism as embodied feelings [Kiverstein et al., 2019, Nave et al., 2020b, Joffily and Coricelli, 2013, Van de Cruys, 2017, Hesp et al., 2021]. The positive and negative valence that accompanies our experiences is a reflection of the quality of our policies. We can think of valenced feelings as a bodily barometer that informs the agent how it is fairing in its predictive engagements [Barrett, 2017, Pezzulo, 2014]. If error reduction is slower than expected, there is an increasing disattunment between the organism's model and its current environment, and this change is marked by feelings of frustration and disappointment. These negatively valenced feelings act as feedback about the reliability of the currently selected action policies. In contrast, when error is being reduced at a better than expected rate then the organism is successfully predicting the current situation, and the bodily feedback is positive feelings of hope and satisfaction that in turn increase precision on that policy. Predictive systems, like us, have evolved to make use of this embodied information to make adjustments to precision on action policies. According to this work, the affective valence acts as a domain general controller that tracks and assigns precision on action policies in line with changes in how fast or slow error is being reduced relative to expectations. These feelings provide a pre-reflective source of information about the agents fitness, as well as provide the agent with a feeling of what is possible or not possible given their skills and the context. The fact that these bodily feelings drive policy selection means that one literally feel what possibilities are relevant to us, and are bodily moved to improve.

Policy selection is not just based on how likely it will lead to expected outcomes, this process also relies on the expected rate of error reduction [Miller et al., 2020a]. An agent selects a goal and gets ready to act, partly based on how fast or slow overall prediction error will be reduced over time [Schillaci et al., 2020]. It does so because the monitoring of prediction error dynamics, provides an overall signal to the organism about how well it is doing in its attempt at tending towards an optimal grip on its environment (we will discuss this notion of optimal grip in section 6) Precision is set, in part, by neuromodulatory chemicals such as dopaminergic discharges Friston et al. [2012b]. These same neuromodulatory chemicals are thought to play a critical role in attuning cortical processing to signals coming from within the organism's body that are essential to life maintenance [Lewis and Todd, 2007, Miller and Clark, 2018]. The tight relationship between dopamine activation and motor activity allows changes in rate of prediction error reduction to motivate and direct action policies, as well as producing feelings of pleasure when prediction error is effectively

reduced (and displeasure when it is not) [Friston et al., 2014, Van de Cruys, 2017]. Notice here, that the drive to attain rewards is recast in active inference as the drive to reduce discrepancies between expected or future sensory states compared with current sensory states. So for example, eating when we are hungry is rewarding because of its precision in terms of the potential to reduce the prediction error produced by low blood sugar levels. Rewards, then, according to this framework, are the sensory states we highly expect to be in. Thus, precision weighting is adjusted on action policies not only based on the amount of prediction error (or prediction error minimization) occurring in the system, but also the rate at which prediction error is managed over time.

If precision is set based on estimations of how likely some action is to lead to the expected result, then the efficiency - the speed at which prediction error is reduced - of those actions matters Bucher et al. [2020]. Selecting an instrumental action that maximize reward in a familiar context, a highly-precise policy, should generate expectations about an extremely fast prediction error reduction rate Nave et al. [2020b]. When executing this policy, the monitoring of prediction error dynamics should indicate a fast rate of progress towards the selected preferred outcome. If for some reason, prediction error continuously increases, a disengagement from the policy should occur and a decreased policy precision will be set in that specific context. On the other hand, when an epistemic action is selected to seek new experiences that maximize information gain, the expectations about the prediction error reduction error rate associated to the policy tend to be slow but reducible Kiverstein et al. [2019]. Considering that prediction error dynamics could be seen as a self-regulating mechanism, being intrinsically motivated to explore and learn should constrain the selection of policies to those that generate reducible prediction error given the current capabilities of an agent [Schillaci et al., 2020]. Thus, when executing an epistemic action, the monitoring of prediction error dynamics should indicate a rate of progress, because if this does not happen, this action should be avoided until the capabilities of the agent improve.

Policies that are inefficient need to be avoided in favor of policies that make the most of our limited resources. Organisms that aim to reduce prediction error over the long term benefit from being sensitive to changes in the rate at which they are reducing error - that is, at the efficiency of their policies. If dopamine is responsible for setting precision on action policies, and the wider dopaminergic system is particularly sensitive to changes in the rate of prediction error reduction [Kiverstein et al., 2019], then we have good reason to think that assigning precision to action policies will be work best done in part through keeping track of prediction error dynamics. Furthermore, since prediction error dynamics are felt in the body, there is good reason to think precision weighting of policies is tuned in part through using feedback in the form of bodily feelings [Joffily and Coricelli, 2013, Schillaci et al., 2020, Kiverstein et al., 2019]. Precision weighting then is not just a brain event. Precision expectations are tuned to the context based on bodily feelings that track and leverage opportunities to improve in our skillful engagement with the world.

In this section, we have outlined recent work on bodily feelings as tracking and leveraging how well the predictive organism is doing at maintaining a good predictive grip. This second-order bodily information is used to make ongoing real-time adjustments to the precision on their beliefs about policies. Predictive organisms, from this perspective, then are not only interested in keeping prediction error to a minimum in their sensory exchanges with the environment in order to maintain themselves in their valuable expected states. They also are sensible to the changes in the rate of error reduction to reduce prediction error over the long term in an optimal manner. Embodied feelings are key for predictive organisms, because they are experienced as a reflection of the quality of the policy being enacted in relation to their expectations about performance, or their expected error reduction rate. The sensitivity to the rate at which errors are being reduced shapes the patterns of attention towards self-relevant policies that tend to increase their optimal grip on the situated environment.

3 Cultural patterns of attention

When immersed in a culture, agents optimize cognitive metabolic costs by developing automatic selective attentional preferences to those relevant statistical regularities shared in that culture [Veissière et al., 2020]. These shared regularities driving attention and epistemic gathering are often referred to as scripts in sociological and psychological sciences [Albarracin et al., 2021]. Thus, culture can be understood as a type of pattern which defines where individuals will focus their attention. Cultural patterns of attention can be defined as 'regimes of attention' [Constant et al., 2019, Ramstead et al., 2016]. Regimes of attention are shaped by cultural practices, guiding individuals' attentional styles, and the way selective attention is deployed during action-perception cycles. Importantly, attention mediates the sensory feedback loops that will be processed, and as a consequence, the shared expectations that will be encoded in the levels of the cortical hierarchy of individuals immersed in a culture [Ramstead et al., 2016].

Regimes of attention are not equally shared across all cultures. Cross-cultural variations in the patterns of attention may play a central role in explaining cultural differences, such as causal attribution and interpersonal perception [Masuda and Nisbett, 2001]. Endogenous, top-down, goal-driven attention is of particular relevance for understanding cultural variations in the patterns of attention. Cultural differences can be understood in the way attention is deployed in

specific circumstances by means of shared expectations. The immersion in cultural context structures expectations through participation in patterned cultural practices. Individuals are constantly adjusting their behavior towards what is relevant to others, what they expect, and expect them to expect. Regimes of attention make the social solicitations salient in context, allowing the learning of those conventional relevant affordances in a given culture, community or local world. Regimes of attention involve correlated cues of the environment and opportunities for epistemic actions organized in terms of cultural activities, norms, and practices which correspond to the salience or epistemic affordances of cultural information embodied in the epistemic cues of the environmental niche. By means of active inference, over the situated cultural niche, individuals learn the norms and the contingencies that define their local cultures. Individuals maintain their organization minimizing prediction error of its phenotypic expected states with regard to the states in their environmental niche.

The entirety of the individual's existence defines the self-relevance, salience, and meaning of different elements of the environment. So while some things in the environment carry possibilities of action for the individual, given their bodies, skills, and cognitive tools, their relevance changes dynamically given the specific internal and external context perceived [Kiverstein et al., 2021]. Affordances are defined as perception and action possibilities that are latent in the environment and are always in relation to the individual [Gibson, 1977]. In this regard, the nature of human culture is to assure that specific well-bounded and highly valuable states are frequented [Veissière et al., 2020], in the dynamic field of relevant affordances that stand-out as salient in a situated moment [Bruineberg and Rietveld, 2014].

3.1 Cultural affordances

Individuals navigate their environments by being able to gather meaning from the landscape of affordances. The landscape of affordances can be defined as the total available affordances at the population level in a given environment or niche [Ramstead et al., 2016]. The field of affordances are emergent possibilities of action, the dynamical relational properties between individuals and the environmental elements that stand out as relevant [Bruineberg and Rietveld, 2014]. The central element of the field of affordances is thus local and situated relevance, which is given to the individual by attention grabbing elements of the surrounding. Individuals tend to focus on those environmental elements which carry some goal-oriented relevance and that allow to accomplish those goals [Kiverstein et al., 2021]. Importantly, individuals' concerns are guided by their socio-cultural practices which, in part, determine what shows-up as relevant in the field of affordances [Rietveld, 2012, Bruineberg and Rietveld, 2014]. Cultural patterns of attention, and shared expectations, shape the affordances that are relevant and salient in a given moment. Cultural knowledge is full of meaningful content because it is about how we think and behave, guiding our attention to salient events during embodied interactions. Thus, culture acts as a bridge between internal notions of self-relevance, and the external view of what is relevant in a given context. The members of a culture interpret events in culturally meaningful ways [Senzaki et al., 2014]. Specifically, meaning is assigned to signs in terms of what they can afford for socially relevant goals.

Cultural context emerges from the coordinated actions and attentional practices of individuals immersed in a group. Thus, actions are guided by shared patterns of attention that determine the field of relevant affordances which can be conceptualized as cultural affordances (see Figure 1). Ramstead et al. [2016] suggested that possibilities of action can be classified in two types of cultural affordances, natural and conventional affordances. "Natural affordances are possibilities for action, the engagement with which depends on an organism or agent exploiting or leveraging reliable correlations in its environment with its set of abilities. Conventional affordances are possibilities for action, the engagement with which depends on agents' skillfully leveraging explicit or implicit expectations, norms, conventions, and cooperative social practices." [Ramstead et al., 2016, p. 2]. Additionally, conventional affordances also include social affordances, which are defined as those possibilities of social interactions offered by the environment [Rietveld, 2012]. Social affordances reflect the meaning of symbolic and non-symbolic behaviors [Loveland, 1991]. Symbolic behaviors, such as language, are specific for each culture. On the other hand, non-symbolic behaviors are not necessarily culture-specific such as facial expressions, body postures, and other social information about individuals in a context. The responsiveness to natural, conventional, and social affordances has a normative dimension within a particular socio-cultural context [Rietveld, 2008, Albarracin et al., 2021].

Of particular relevance here, cultural affordances acquisition by regimes of attention can be conceived as a manipulation of attention, determining the shared expectations and as a consequence, the selective engagement with the field of affordances [Ramstead et al., 2016]. Recently, the way affordances are conceived under the active inference framework has been criticized. Specifically, the criticism points to the redefinition of affordances in terms of action-selection preferences. This definition contrasts the traditional view of affordances based on the relational property in the organism-environment system, which has no need to be inferred Raja et al. [2021]. Here, as [Raja et al., 2021], we agree that the tacit relationship of an affordance either exists or does not. However, it is important to highlight that what has to be inferred is not the affordance per se. The inferential process lies in how affordances are selected in a context and in a culturally-sensitive manner. This is the process by which individuals respond and select an affordance

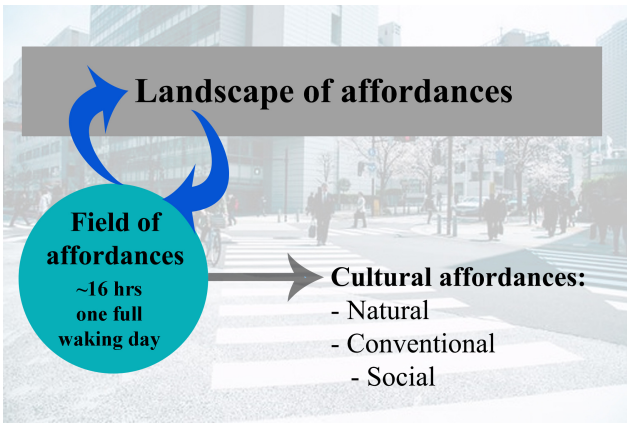

Figure 1: Schematic representation of the total landscape of affordances and how the field of affordances dynamically emerges. The field of affordances is constituted by cultural affordances, classified as natural, conventional, and social. The salience of relevant affordances is shaped by culturally shared patterns of attention and determined in a contextual-sensitive manner.

engagement from all the solicitations present in the field of affordances. For instance, the selection of a bathroom according to gender is guided by a code on the doors, and expected social compliance to gendered behavior [Albarracin, 2020]. Thus, in the field of affordances, the way attention is deployed depend on how precision weights modulate the salience of relevant affordances, which increases the probability that they will be enacted [Friston et al., 2012a].

Recent changes in technology have also had drastic impacts on cultural fluctuations. For example, gender has become more blended in highly urbanized areas in such a way as to make a lot of the same affordances available to all genders alike. This has the consequence of possibly making gender more easily fluid for younger individuals [Albarracin and Poirier, 2020]. Hence, it bears questioning how technology affects how norms, social practices, and in general, how cultural knowledge is acquired. Even before COVID-19, we have been able to observe a decline in real life weak ties communities, as people spend less time outdoors, and thus are less aware of the people around them geographically, or in their community. Inversely, communities have developed online, through computer mediated communication [Blanchard and Horan, 2000].

4 Technological and digital affordances

Affordances are fundamentally interactive, depending on the current individuals' concerns and the elements that are present in the situated environment. In a great diversity of cultural niches, technological tools, such as digital devices, are elements that are present in the environment more and more frequently. Additionally, the COVID-19 pandemic brought deep changes in the way vast socio-cultural practices are carried out. Hence, nowadays individuals are immersed in both an offline geographically situated culture and an online digital culture, which together shape the patterns of attention that will be learned. As a consequence, the landscape of affordances will also include technological and digital affordances. Technological affordances make reference to the attributes of both the technology and the user, the interactions between the technologies and the people who will use them [Gaver, 1991-03]. Digital affordances can be understood as a socio-technical concept because they are related to the material properties of technology and to the relationship between these properties and the diversity of their social uses [Deseriis, 2020]. Digital affordances are defined as online possibilities of action. They are closely related to technological affordances because online digital engagements need the use of technologies.

Given the importance that the digital world has taken in our lives, and the extent to which it is populated, digital affordances have become an enormous part of our landscape of affordances. The field of affordances contains both, cultural affordances, that are enacted in the offline physical world, and digital affordances, that are enacted in the online digital world. Digital affordances are a particular type of conventional affordances, and are also conformed by digital social affordances (see Fig. 2) . Here, digital social affordances are defined as online possibilities of social interactions. Since cultural affordances are, in part, pre-scripted by the social environment, we strongly respond to emotional content related to social interactions. Therefore, digital social affordances should be highly salient in the field of affordances because they allow immediate engagements with already relevant social affordances in the offline physical world. But, does our field of affordances is really moving towards digital affordances, and specifically, towards digital social affordances?

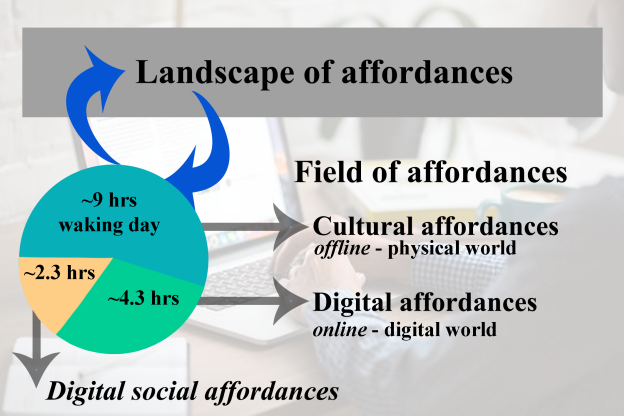

Figure 2: Schematic representation of the landscape of affordances and how the field of relevant offline cultural affordances and online digital affordances dynamically emerges. The distribution of the global daily waking day time spent in offline cultural affordances, online digital affordances, and digital social affordances, is represented in blue, green, and yellow, respectively (data from [Annie, 2021].

4.1 Bidirectional functionality of digital affordances

Digital social affordances, present on social media, are particularly complex types of affordances because they function in a bidirectional way. A platform-sensitive approach to affordances needs to consider not only what the technology affords to users, but also what users afford to platforms through their socio-technical properties. Machine learning algorithms learn, predict, and respond to user interactions adapting to what users would like to see. Clicking and liking actions performed by users feed the algorithms towards learning new user affordances, and as a consequence this fuels the interest and interactions of users to keep them engaged [Bucher and Helmond, 2018]. This bidirectionality is produced by design. Digital technologies are created by humans and thus they are interwoven with political, economic, and cultural influences. Digital social platforms also are affected by the same influences determining the choices that third-party marketers and designers make. These choices of digital affordances are meant to optimize commercial interests. Designers of social media platforms control and decide how information is saved, and how tools, options, and buttons are designed to magnify these digital social affordances.

The visual elements on digital social platforms carry information that allows exchange and communication. They afford a variety of meanings and actions, that have consequences beyond their individual parts. 'Likes' and other social interactions in digital social platforms, have several emotional components. They are related to the individualized satisfaction of the users desires for ephemeral happiness, standardizing thoughts. "In the face of uncertainty, the ceaseless media-cultural bombardment system is therapeutic." [Giraldo-Luque and Fernández-Rovira, 2021, p. 291]. The emergent properties of meaning that are assigned to some features are part of the socially negotiated affordance landscapes [Bucher and Helmond, 2018]. Emergent meanings are thus sometimes interpreted literally, as the content itself, and as approval of the content itself. Sometimes, the small information given through a 'like' is more about acknowledging that the information was integrated without giving a specific valence to it, or specifying that the information will be kept for the future. 'Likes' can also be a form of social support as they groom agents towards a type of content or behavior. 'Likes', thus foster a specific type of behavior through social acceptance, shaping our actions, the images we share, and the way we communicate, to guarantee an acceptable percentage of 'likes' that makes us feel happy [Giraldo-Luque and Fernández-Rovira, 2021]. Reciprocity of 'liking' between members of a community is also a form of informal etiquette and relationship preservation. Even when the behavior 'liked' is not specifically supported, it signals that a link is intended to be maintained, and improves the chances of further content being supported. It thus serves as a social capital. Finally, 'likes' also serve to keep track of content, and keep a record of it, archiving knowledge for later use, and tailoring the content archived and thus the easily available knowledge which becomes more salient [Hayes et al., 2016].

Individuals feel more 'connected' to people when they receive likes, notifications, comments, or as they 'gain' more friends. Thus, the affordances in digital social platforms are very salient because they are motivating for gaining knowledge, social support, status, and for building a self-identity. As individuals become the product of the information society, what they really aim is to reduce vital uncertainty, build an identity, and to satisfy the need for social acceptance [Giraldo-Luque et al., 2021, Giraldo-Luque and Fernández-Rovira, 2021]. The data produced by individuals is what is valuable, being very far from a humane model of value creation. The 'datafied times' we are immersed in now, aim to

keep users' producing more data to gain more value [Barassi, 2020]. The strategy behind is amplifying what attracts users' attention [Harris, 2017-04]. Learning algorithms need the active participation of users to generate relevant data for training [Arrieta-Ibarra et al., 2018-05]. These algorithms are tools that will find those patterns that will change the behavior of the users [Lanier, 2018-07-15].

In the 'free-online' culture model, users do not pay for using digital social platforms, and neither are paid for the data they input into digital services [Arrieta-Ibarra et al., 2018-05]. The perceived 'fee-online' culture by users, is the strategy that makes users to ignore or avoid what really means to delegate the property of their data. Social advertising budgets were expected to increase by 2021 due to their impressive ability to reach their target customers [Annie, 2021]. Consumers lose their data freedom voluntarily in order to receive free services such as social network platforms and web search engines in exchange for consenting to being spied upon. With the information gathered, algorithms predict their actions, turning their life activities into the greatest fortunes in history.

The billionaire value of digital social platforms comes from the millions of users who contribute to the network without being paid for it [Lanier, 2014]. For users this is not transparent, and when engaged in digital social platforms it seems difficult to understand that the main aim behind this technological tools is to generate more data and more value. The 'datafied times' we are living determine how digital social affordances are designed. What we want to highlight here, is that these digital social platforms are not equivalent to the offline situated social interactions because their structure is built, mediated, and defined by third-parties with diverse interests. Digital social platforms are a super-stimulus that take advantage of what we naturally feel attracted to, amplifying our human biases and tendencies, by offering digital social affordances intentionally designed to provide an immediate rewarding experience.

5 Active inference and digital social affordances

When it comes to the digital world, an individual needs to infer sets of expectations in accordance with the online digital media it is engaged to, determining the meaning of events and symbols, as well as the appropriate behaviors and conceptual narratives to communicate. Digital social platforms enable online social interactions and ways of communicating with the online community which are particular to each platform. Considering that conceptual narratives are context-sensitive, individuals must learn the digital social affordances that are salient in the digital social platforms they engage with in order to select those ones that are very likely to minimize prediction error. Digital social affordances are learned by means of how precision weights are modeled during digital interactions which are guided by highly salient social cues and the embodied feelings product of the monitoring of prediction error dynamics. Individuals encode in the cortical hierarchy the sets of expectations that correspond to each of the preferred social media platforms, in order to selectively engage with those relevant digital affordances to minimize prediction error. Digital social affordances are encoded as preference distributions over highly valuable and rewarding social digital experiences.

Digital social platforms afford two categories of digital actions, instrumental actions and epistemic actions. First, digital instrumental actions are extrinsically motivated behaviors directed towards preferred social outcomes. This type of digital pragmatic policies are highly precise, reflecting the expected evidence given the social outcomes they search for. Second, digital epistemic actions are intrinsically motivated explorative behaviors directed to maximize information gain to find out rewarding social experiences. This type of information-seeking and novel-seeking curious policies have an associated expected prediction error given the information gain they pursue for belief updating. The process of selecting digital policies that maximize instrumental or epistemic value occurs in a context-sensitive manner.

5.1 Digital social affordances and prediction error dynamics

Contrary to digital social platforms, the shared patterns of attention in a culture play a relevant role to code shared cultural expectations which help to reduce the cognitive metabolic costs for minimizing prediction error [Ramstead et al., 2016]. They are built with the aim of maintaining our connection to the platforms by presenting salient and attractive information that will minimize prediction error only if the engagement continues. Thus, social media platforms are design in such a way that the task of minimizing prediction error appears "easy" to the user, as it tends to reduce in a very fast rate. Digital affordances are "naturally" attractive, maintaining our attention by means of the pleasure that arises when being constantly rewarded throughout prediction error minimization. In other words, being sensible to prediction error dynamics makes digital social platforms a technological tool highly attractive for users as they are built taking advantage of our natural tendency to minimize prediction error in social contexts.

Digital social platforms provide many different types of digital affordances. Here, some common ones are analyzed placing them into two categories: self-identity formation and belief updating. This division is based on the effect that prediction error minimization and its respective expected rate have on users' beliefs about themselves and the world, while engaged with such platforms. Digital affordances such as profile making, editability, audience curating,

Digital social affordances	Digital action		Desired outcomes	Design strategy
	Epistemic	*Instrumental*		
Self-identity formation				
Profile making		X	Social approval, visibility, niche fitting, editability, relatedness, social competition (envy or admiration)	Access to highly relevant demographic information about users, control the type of accepted identifications
Information sharing	X	X	Visibility, association, identity evaluation, social validation and support, editability, social support, identity exploration, playact, violate social norms	What is on the user's mind, what is the user doing, where is the user spatially located, add pictures and videos, instant-direct messages, share buttons in other web sites, edit posts, delete messages
Appearance changing	X		Editability, social approval, hyper-speed comparisons, self-appearance information gain	Provide desirable AI-filters of sociocultural appearance, AI-filter to edit background, preference tools for changing profile appearance
Audience curating		X	Niche construction, identity confirmation, saving face, trust, association, social relatedness	Suggest friends people or interesting groups to follow, peek others' friends to follow, unfollow
Metavoicing		X	Provide collective feedback, communicate with others with minimal effort, visibility, social evaluation, niche construction, relatedness	Enabling emotional reactions (likes, dislikes), sharing-retweet, follow or unfollow users, provide visible metrics or 'scores' associated to a conversation
Belief-updating				
Infinite scrolling	X	X	Novelty seeking, encounter self-relevant information, find out digital social solicitations	Engineered preferences about relevant social content, adds, news, endless feeds with novel but relevant content
Information search	X		Information gain, keep up-to-date on social events and news, reduce uncertainty about novel or controversial situations, belief confirmation, gossiping	Engineered preferences, search tools about events and other users, present belief-consistent information, trending topics
Notifications checking	X		Immediateness, expect social rewards, self-relevant information gain, visibility, relatedness, reduce fear of missing out relevant information	Trigger attention automatically to notifications curated by users, using sounds and/or visual pop-outs, present few but relevant information, suggest to turn-on notifications to keep-up to date
Cosurveillance	X		Monitoring others, social connectedness, immediateness, information gain, hyper-speed social comparisons	Notifications, providing endless social/friends feeds, prioritizing friends' stories, sharing current location, allowing to see others' followers/friends

Table 1: Digital Social Affordances

information sharing, and metavoicing, are considered here as central to self-identity formation. Under an active inference view, identity-formation is intrinsically related to the process of belief updating. However, although it is difficult to make a clear-cut distinction, digital affordances such as infinite scrolling, information search, cosurveillance, and notification checking, are of particular relevance for the process of belief updating without necessarily having an effect on how self-identity is built.

5.1.1 Self-identity formation digital social affordances

The internalization of sociocultural appearance standards is needed as a first step towards a stable personal identity. Identity can be understood as a stable, constant, and identifiable form of behavior which reflects a way of being in the world acquired by means of bodily practices and habitual performance [Wehrle, 2021]. Additionally, identity formation is achieved through cycles of social active inference to learn relevant sociocultural norms as self-priors -narratives- that function to guide active inference towards those goals congruent with the "self" [Tremblay et al., 2021]. Self-identity is built in a social structure with social roles, in such a way that the 'self' has several identities with differential salience for each self-in-role that might change over time and/or context [Stryker, 1968]. The salience of an identity in the 'self' is the probability of an identity being enacted, and in doing so, the behavioral choices related to that identity will be performed according to the social expectations associated to that identity [Stryker and Burke, 2000].

In digital social platforms, much like offline social communities, views of the world are shared, and serve to coordinate, like a massive cognitive tool [Sachan et al., 2012]. The difference mostly concerns the scale and breadth of the networks. Construction of the self in digital social platforms is thus rooted in several online communities and how they possibly see the self. In a sense, we can consider social media as an extended cognition, that essentially represents contextual self-esteem [Zhong et al., 2017]. However, in digital social platforms the cycles of social active inference for self-identity formation are mediated by digital affordances build by third-parties with economic interests. These digital affordances, closely related to self-identity formation, can potentially place into risk users' self-esteem, as well as the salience for each self-in-role both in the physical and in the digital world.

It is important to keep in mind that digital social platforms are not specifically designed for underage users. Despite this, there are plenty of underage users, and in fact, the COVID-19 pandemic caused an even earlier age entry. The use of smartphones and the time spent on digital social platforms had substantially increased the perception that parenting is harder today than 20 years ago [Auxier et al., 2020]. Social media platforms need to be analyzed through a developmental and culturally sensitive lens [Odgers and Robb, 2020]. As we will analyze in this section, digital affordances related to self-identity formation, specifically on digital social platforms, can negatively impact the way self-identity is developed at all ages. However, we believe that underage users are under a greater risk because they are under a crucial developmental stage for self-identity formation [Odgers and Robb, 2020].

Digital social platforms provide specific tools that afford their users to construct a desired identity by means of a profile (**Profile making** in Table 1), which contains information about the individual. Individuals are connected through digital social platforms, where their profiles and its corresponding data are visible, and the content generated by the users is usually in relation to their profile [Zlatolas et al., 2019]. The construction of the self will depend on what type of audience one expects to encounter on the platform, and what habitus is thus transferred to reality into the virtual realm [Zhong et al., 2017]. Profile making affords digital instrumental actions directed to preferred social outcomes such as social approval, identity validation, social competition, provoking envy or admiration, among others. Users craft images of themselves that allow them a better fit to a specific version of the world. By crafting an ad-hoc profile, they can avoid having to change themselves in the physical world to fit in niches, minimizing their prediction error, both in fitness and energy expended in becoming fit to the environment. Therefore, when users make their profiles, the expected rate of prediction error reduction is fast, and when error is reduced, sometimes better than expected, it provides satisfaction. Achieving the preferred identity, as the outcome of profile making, increases the quality of this policy. Subsequently, if their audience validates the identity they put out into the digital world, and reinforces their sense of fitness, as well as their self-evidencing, profile making attracts a lot of attention in the landscape of digital affordances.

Profile making related affordances are designed to provide users relevant possibilities for shaping their profile according to the digital social shared expectations. However, the strategy behind the design of this type of affordances is to access highly relevant demographic information about users, and for doing so, designers commonly constrain the possibilities of accepted identifications. For example, for Facebook's third-party marketers and data companies, gender is considered as a highly relevant demographic information about users. In Facebook, heteronormative male and female identifications are the only options. This example illustrates how Facebook potentially proliferates social division and misrepresentation about culturally accepted norms [Cirucci, 2017].

In digital social platforms, it is also possible to edit and share versions of oneself that seem positive, like enhanced photos, or positive events in ones lives without the negative ones. Platforms give users the affordance of **Appearance changing** (Table 1) by editing their digital physical appearance and even the place they are at when taking a selfie

or making other digital content such as videos. Of particular relevance here, appearance changing affords users to explore beyond their real appearance and body-image for social approval. Artificial Intelligence-augmented photo editing tools are designed to give users the possibility to immediately change their own image by applying filters of desired sociocultural appearance standards [Tremblay et al., 2021]. For example, some of those filters provide users to change their skin color, eyes and nose size, body shape and weight, makeup, hair color and style, skin imperfections, accessories like earrings, among many others.

Appearance changing affords to users digital epistemic actions to gain novel information about the effects of making specific changes in their appearance for social approval. If a design tool affords appearance editability, during its engagement, prediction error rapidly increases as the resulting self-image can differ greatly from reality. However, the expected rate of prediction error reduction is fast due to the hyper-speed in which users can compare the results from different filters to achieve the desired socially-expected appearance. Appearance editability-related behaviors should increase the salience of these policies in the landscape of digital affordances, and at the same time may increase the precision of the related policies that bring about the socially-expected and rewarding appearance. Directly placing sociocultural standards to the user's photos changes what is "normally expected" by repeated exposure and promotes a visual normalization of a AI-filtered self-image, leading to a maladaptive internalization of unrealistic appearance standards and sociocultural norms [Tremblay et al., 2021]. As a direct consequence, users start to feel uncomfortable with the way they really are, their self-image in the mirror, preferring their digital image [Pescott, 2020, Burnette et al., 2017, Chae, 2017, Chua and Chang, 2016]. Given the difficulty of changing the physical appearance, digital instrumental actions related to image modification are selected (e.g. AI filters) due to their potential to minimize prediction error, increasing the precision of these policies and the time spent in digital social platforms.

Instagram, a digital social platform owned by Facebook, is an entirely visual platform where users share images or videos with enhancing AI-based filters. In September 2021, a leak to The Wall Street Journal from internal Facebook's research about how Instagram affects teenagers well being and their body image perception, demonstrated that the company is aware of its toxicity. Slide presentations posted to Facebook's internal message board in 2019 and 2020, included statements such as: "We make body image issues worse for one in three teen girls", and "Teens blame Instagram for increases in the rate of anxiety and depression. This reaction was unprompted and consistent across all groups". However, executives from the firm, publicly state that in fact digital social platforms tend to have positive mental health effects, and that their research suggested that effects in teenagers' mental health were quite small [Wells et al., 2021].Digital social platforms, specially those that provide AI-augmented photo editing tools, can potentially lead to maladaptive internalization of unattainable appearance standards, such as what Tremblay et al. [2021] termed as "Snapchat dysmorphia".

Another digital affordance related to self-identity building is **Audience curating** (see Table 1). In digital social platforms, users can select other users and friends to be connected when curating their own audience, as well as they curate themselves by selecting which audience to show a different image to. Individuals craft their entire self-image, their own identity, categorizing themselves into a profile that fits to an audience. Audience curating affords to users digital instrumental actions to directly construct their niches to reflect their beliefs, as well as to shape different segregated arenas for which they will construct different identities or profiles. Thus, a new dynamic, enabled by digital social platforms, is that networks have become more personal, they are tailored to the agent's specific desires and interests. Concurrently, instead of the agent having to learn how their direct community interacts, and bend to it, agents have more leeway to simply find other agents who tend to think and behave like them [Postill, 2008]. This is especially true since virtual communities tend to focus and gather people around specific interests [Blanchard and Horan, 2000]. The expected rate of prediction error reduction, related to users' specific social norms and behaviors, becomes then extremely fast and rewarding. As a consequence, audience curating related policies are highly precise. Attention is deployed with ease to these affordances because they are related to the users' identity confirmation and social relatedness. When this behavior is not manageable or becomes unpleasant, the user can easily look for a more suitable audience, instead of having to change its own behavior with respect to the expectations of the community.

Further, **information sharing** (See Table 1) depends on the audience of any given members of the community. Curating one´s own audience and the shared information given that audience allow users to, among other things, *save face* [Gibbs et al., 2013]. Embarrassment can be avoided by sharing information only in groups where it is normative to share it. More complicated groups increase the necessity for a trust system. Trust is made relatively more difficult on virtual communities, because identity can be obscured, and statements can be edited after the fact. Similarly, people have more time to craft their responses, which makes it more difficult to detect anomalies, like we would in face to face interactions [Blanchard and Horan, 2000]. Having time to craft responses is a type of instrumental action that allows counterfactual prediction error. This means that, when sharing information, digital social platforms give the opportunity to avoid unexpected social outcomes, and if they still occur, editability affords policies that minimize prediction error.

Users are aware of the type of communication expected of them on digital social platforms [Zhong et al., 2017]. Each platform affords a specific way to share information because of the shared expectations between users. The digital instrumental actions that will lead to the desired social outcomes are selected considering what they expect about others' reactions to the information shared. However, when sharing information in digital social platforms, the way instrumental and epistemic actions are selected is different than in offline social interactions because users' identity is crafted. Digital information sharing allows users to explore new identities, behaviors, and their related outcomes, as well as to freely express socially reprehensible aspects of their identities which can violate social norms. For example, they may perform discourses differently, express opinions they would not otherwise express offline and with a tone they would not otherwise use, such as aggressiveness and violence. Individuals can freely signal their political identity, or their in-group belonging by performing their politics online, even if they do not necessarily belong to an effective group in their offline life. This group membership can be manifest online, but clash with the reality of isolated individuals who then have more incentive to give all their attention to the digital way of life.

Comparing ourselves to others and considering cultural norms allows us to find meaning, motivation, purpose, and a sense of identity. In social media platforms and because of the use of smartphones, this evolutionary process happens extremely fast, in such a way that hyper-speed comparisons become biased towards positive information about others [Veissière and Stendel, 2018]. Social media shared images tend to project a self skewed towards overly positive representations, whereas the reality may be more complicated, difficult or even outright different. This positive bias towards others, paradoxically, tends to increase a negative bias towards self-evaluations. For example, experimental evidence has revealed that people feel depressed after spending a great amount of time on Facebook as a consequence of comparing themselves to others [Steers et al., 2014]. The social pressure from witnessing others be so positive and fitted to the sociocultural appearance standards, turns information sharing a highly salient digital affordance to project such an image to receive social approval. When social approval is received, the policies related to this outcome become highly precise. In the physical world, projecting this curated content about the self may be harder to achieve, or even impossible. Thus, the expected rate of prediction error minimization related to those policies associated with preferred social outcomes should be very slow in comparison to the expected rate that has been learned in the digital world.

As individuals grow accustomed to digital social platforms, and because they can curate their audiences, privacy concerns are lessened. This suggests that our notion of intimacy and privacy has changed during digital social interactions [Fogel and Nehmad, 2009]. Members of a group assume shared similarities and when individuals perceive similarity to themselves, they are more likely to trust their members [Blanchard and Horan, 2000]. It is possible for any given group to become a community as soon as it solidifies and offers individuals the seeds of an identity [Postill, 2008]. Belonging is another factor which is emphasized and primed in among the members of a community. With increased trust and belonging, digital social platforms afford massive information sharing, whether it be in terms of sharing to a group, or to an individual. Individuals often share, willingly, very private information about themselves, that is then used to target them for advertising, or for data mining. In fact, being less concerned with privacy on social media correlates with being more prone to risk-taking. Consequences from the social system do not seem to be as prevalent for people more likely to share their intimate lives on social media [Fogel and Nehmad, 2009].

Just like in any community, online communities carry social capital, norms and trust that facilitate coordination for mutual benefit. This entails that certain communities may create benefits for some or all of their members when they abide by these norms [Blanchard and Horan, 2000]. Trust enables social capital and eases the transactions through cooperation. Trust increases when there is a tighter network, and clear norms of reciprocity. Due to the fact that online communities do not have to be geographically located, exchange of information or social support is the key to social capital. Given the massive scale of digital social platforms, created value in virtual networks stems from the increased possibility for voiced support, and information. Questions will find answers, and statements will find proponents. The more proponents behind a statement, the more likely it is to gain traction, and thus provide capital to the people who propose such statements.

Underlying these interactions is the notion of time. Internet permits asynchronicity of interaction, and lasting signals. Specifically, if something is said online, it can be seen for a lasting amount of time. Reactions to expressed ideas can also last, echoing through time, in a way that amplifies the possible reactions [Postill, 2008]. More useful, interesting, and surprising content of the information, which evokes emotions that increase arousal, has a greater likelihood of being shared. It seems relevant to consider these psychological processes that shape social transmission and collective outcomes, such as information becoming viral [Berger and Milkman, 2012]. In digital social platforms, false information spreads easily and in a highly impactful manner [Kumar and Shah, 2018]. For example, on Twitter, in all categories of information, false information spreads faster and more broadly than true information. False information usually offers a high degree of novelty and it evokes emotional reactions such as great surprise and disgust. These characteristics may explain the greater likelihood of people to spread false information.

Some of these affordances relate to deeply social mechanics allowed by the technology itself. **Metavoicing** (Table 1), is an affordance that allows users an engagement with ongoing online content by reacting to others' presence to massively offer feedback on an idea Majchrzak et al. [2013]. Metavoicing is addressed in the literature in part as a paralinguistic digital affordance. The ability to like statuses and knowledge elements gives agents a specific power. An affordance like metavoicing is intrinsically related to the affordance of information sharing. When users share information, at the same time they expect others' reactions by metavoicing. Although, both affordances provide the possibility to share information, their main distinction is that the actions related to metavoicing carry very little information. Additionally, they are also easy to use, and thus travel easily and with efficiency [Hayes et al., 2016]. "Likes" and other emotional reaction buttons, retweeting, voting on a comment, among others, are instrumental actions that provide collective feedback and belonging with a minimal effort. Due to the associated minimal effort, the expected rate of prediction error reduction associated to a specific affordance designed for metavoicing is extremely fast.

Through paralinguistic communication, individuals share information, communicate their emotions and/or approval, increasing their feeling of being connected, and the sense that their opinion matters. In doing so, individuals increase the precision on their own priors. Receiving the paralinguistic validation increases the user's feeling of belonging, social support, approval-gratification, and a sense that their visibility increases in turn. In this regard, it has been suggested that paralinguistic communication in digital social platforms, makes conversations something like a game [Nguyen and Lackey, 2021]. This game is based on placing metrics and scores on users' conversations, such as how many "retweets", "likes", and/or followers a conversation evoked. Thus, Nguyen and Lackey [2021] proposed that users internalize these metrics as an evaluation, thinning out and simplifying their goals for communication. If these metrics are internalized as an evaluation, when sharing information, social validation can be directly evaluated by the 'score' obtained in a conversation. In digital social platforms, users have expectations about their 'scores', which should have a direct impact on how users perceive themselves. Additionally, a valenced prediction error will be elicited by a 'score' in a conversation, depending on whether the score is better or worse than expected. This valenced prediction error will update the generative model in order to become better on the task of selecting instrumental actions associated to a high 'score' as an outcome of communicating or sharing information.

As users get to witness this massive amount of content and engagement, they are also able to distinguish very quickly whether an action led to a positive or a negative consequence. Through observation of users comments, or through meta-linguistics such as likes, dislikes or retweets, users can get a sense of the socially sanctioned behaviors, or the opinion space of a network, which leads to a change in the field of affordances [Burns, 2015, Yu et al., 2013]. Furthermore, these small amounts of information allow individuals to carry more emergent meaning in their use. For instance, signaling ideological leaning through the meta-relation to the information carried directly by the meme, or the status itself [Hayes et al., 2016]. All these also allows network informed associating, which means to link with other members in order to have a voice in specific topics, and generative role taking (which means roles emerge from the structure, and are not prescribed) [Gibbs et al., 2013]. The users of digital social platforms are aware of the fact that their entire audience may see a message, as opposed to during offline communications where they would be in direct contact with only selected members of an audience.

Additionally, users are aware of the potential of their information being shared beyond their tailored audience. This entails that users maximize how they get validation over information they share, as well as evidence they get from the audience. Digital social platforms act as 'superspreaders', and when they are viewed in this way, they also become a sort of 'superstimulus'. In the same way, expecting more social validation also makes any output on digital social platforms a 'superstimulus'. Given that audiences are tailored by users, the likelihood of validation or epistemic value is higher. As a consequence, users expect to gain a very high value from information related to digital social platforms, making more likely to direct their attention towards it.

Finally, the above mentioned digital affordances, profile making, appearance changing, audience curating, information sharing, and metavoicing, are designed for attracting users' attention to spend more time in digital social platforms for economical purposes. What we want to highlight here, is that the way these digital affordances are designed allows a fast rate of prediction error minimization related to self-identity formation. Although it is highly probable that the strategies behind the design of these affordances were not intentionally for this purpose, users are trading their attention for prediction error minimization. During the engagement with digital social platforms, users learn and become sensitive to those digital affordances that stand out as relevant in the field of digital affordances, and at the same time, users learn to expect a fast rate of error minimization. Thus, as digital social platforms are becoming a new context for identity formation, digital epistemic and instrumental actions associated to self-identity formation have the potential to become highly salient.

5.1.2 Belief-updating digital social affordances

As discussed before, cultural manipulation of attention allows individuals to reduce uncertainty determining how beliefs are updated gravitating towards what is shared as relevant in the field of affordances. Digital social platforms use the same strategy than culture, but what is relevant and salient for belief updating is not guided by the same principles. In the information society we are immersed in, the manipulation of attention aims to generate more data for economical purposes [Giraldo-Luque and Fernández-Rovira, 2021]. The type of information users are exposed seeks to grab their attention independent of its content and the consequences of its spreading. For example, in the digital era, fake news and disinformation have achieved an unprecedented level [De Blasio and Selva, 2021], which has a dire impact on belief updating [Andrejevic, 2020].

The interfaces and the possibilities of action on digital social platforms provide an optimal degree of uncertainty[Giraldo-Luque et al., 2020]. These platforms afford explorative behaviors by, for example, presenting novel and highly salient social information that is endlessly presented. **Infinite scrolling** (Table 1) is an affordance that has received few attention in the literature of digital affordances [Zhang et al., 2020]. However, in digital social platforms, it is a commonly used design strategy to maintain the attention of the users. Infinite scrolling aims at keeping users scrolling their feed using learning algorithms to produce engineered preferences about social content, adds, news, and in general, unpredictable but self-relevant content. Thus, infinite scrolling is an affordance that allows digital epistemic actions not directly related to a specific anticipatory utility, but its salience pertains to please curiosity-related behaviors. An issue that individuals are faced with, is the attentional bottleneck influencing the cognitive selection of information. To deal with this bottleneck, individuals must select information that seems most salient to them. Due to the fact that the content of the feed corresponds to the users' engineered preferences, although prediction error increases as a consequence of encountering novel information, it tends to be optimal for its reduction. By means of monitoring prediction error dynamics, users can select salient but comprehensive information for belief updating associated with a fast expected rate of error reduction.

When users are engaged with infinite scrolling they feel curious about the novel information that is presented, but at the same time they expect to perceive content that will afford other relevant digital actions. In other words, infinite scrolling is an affordance that allows other digital affordances to stand out as relevant in the field of digital affordances. Thus, infinite scrolling also affords a highly precise digital instrumental action, which has as an outcome finding out relevant social digital solicitations. Solicitations are defined as those affordances that stand out as relevant in a particular situation [Bruineberg and Rietveld, 2014]. Here, we suggest that infinite scrolling is at the core of the digital grip, making users respond to those solicitations that stand out from the endless content presented in a digital social platform. It has been suggested that prediction error dynamics are felt in the body, in such a way that precision expectations about solicitations are aligned to the changing circumstances signaled by positively or negatively valenced feelings [Miller et al., 2020a]. Thus, when a user is engaged with infinite scrolling, the monitoring of prediction error dynamics and the associated valenced feelings will increase the attunement with those digital affordances that stand out as relevant. Accordingly, depending on the valenced feeling being experienced by the endlessly changing content, digital affordances such as information sharing, metavoicing, information search, and audience curating, will stand out as salient. The endless salient and self-relevant information that is presented in digital social platforms increases the time users' spend engaged in the platform and promotes digital social interactions to generate more data and more value.

Infinite scrolling is a digital affordance intrinsically related to **information search** (Table 1). Information search is at the core of digital epistemic actions that drive belief updating. Through information search, users select self-relevant novel information and can keep up-to-date on social events and news. Besides infinite scrolling, users can perform other epistemic actions for information gain. For example, the majority of digital social platforms afford searching for, among other things, specific content, keywords, and people. Novel information attracts attention and encourages information sharing because it gives individuals a sense that they improved their understanding of the world [Vosoughi et al., 2018]. This phenomenon is especially salient since encountering belief-consistent information causes a rewarding feeling of sense-making and at the same time reduces the possibility of finding identity-threatening information. In this regard, information search is related to the digital affordance of audience curating, which can lead to problematic effects of ideological silo where the information users receive only resembles what they curated [Gibbs et al., 2013].

Information avoidance, seems to be a paradox in terms of predictive processing [Chater and Loewenstein, 2016]. Individuals are more curious about information that potentially can reduce their uncertainty, regardless whether the content of the information is related to a positive or negative outcome [van Lieshout et al., 2021]. Indeed, individuals should seek to improve their model, but they also tend to validate their current model. In this regard, individuals have a cognitive blind spot for information that is incompatible with their prior beliefs, which can drive to polarization and overconfidence [Hills, 2019]. Selection for belief-consistent information is a tendency to seek out information consistent with prior beliefs which increases with information proliferation. The design behind digital social platforms takes advantage of this tendency by prioritizing the presentation of information that is consistent with users' beliefs to

increase the time engaged in the platform. The novel and belief-consistent information that users interact with, will feed the algorithm engineering preferences to constantly improve it in this direction.

Moreover, information presented on digital social platforms stands out in memory in comparison to other kinds of information. Intentionally, sentences and headlines are crafted to be effortless and readily remembered. For example, breaking news headlines that have a spontaneous tone and a completeness of ideas contribute to memorability [Mickes et al., 2013]. Thus, digital social platforms can be used for information manipulation, as it can be crafted to only represent one aspect of a situation, or garner enough momentum to achieve an epistemic value sufficient to be believed. 'Fake news' can be defined as false information that cannot be disproved, that is published and circulated as being truth, responding to political or economical purposes [Andrejevic, 2020]. Misinformation and 'fake news' have been around since the beginning of human communication, and are by its nature attractive. 'Fake news' proliferation reflects the need and the tendency of individuals to reduce uncertainty by finding plausible answers where none exist yet, which can be understood as an epistemic need. Misrepresentations of observational facts about the world, in some circumstances, can help to restore the meaning and purpose of life, particularly when a person has experience distressing life events [Ritunnano and Bortolotti, 2021].

Taking a functional view of misinformation and belief updating, 'fake news' have the potential to minimize prediction error related to novel, stressful, controversial, or dangerous situations. Believing that something is true can help reduce stress and at the same time can be beneficial for self-identity formation. Additionally, when an epistemic need leads to misinformation, prediction error can be minimized in a faster rate than expected because information is gathered in such a way that it cannot be disproved and it is also enhanced by belief-consistent niches. Thus, belief updating under these circumstances can contribute to building a sense of belonging, evoke positive-valenced feelings, such as relief, comfort, and an increased sensation of being more secure. As a consequence, such beliefs can become highly precise and difficult to change, even under new evidence. In digital social platforms, users' tendency to reduce uncertainty has evolved towards a massive proliferation of misinformation, amplifying the biases on belief updating that were already there. However, it is important to highlight that digital social platforms do not privilege content, they privilege engagement, and information sharing for economical purposes [Andrejevic, 2020].

Moreover, as a product of our evolutionary heritage, we are more sensitive to the social transmission of negative information than of positive information [Bebbington et al., 2017]. This bias towards negative information has a developmental use too, for example, it can help children avoid harmful stimuli [Vaish et al., 2008]. Negative information is useful for survival, which can potentially explain the tendency for its transmission. In this regard, digital social platforms take advantage of this sensitivity to negative information to increase users' engagement and the probability of its proliferation [Hills, 2019]. The algorithms behind digital social platforms' feed, such as Facebook and the family of apps, are skewed towards negative information, hyper-polarizing content, promoting hate speech, divisive political speech, and misinformation proliferation for economical purposes [Pelley, 2021]. Thus, the memorability of the information presented in digital social platforms, its potential use for information manipulation, and the increased sensitivity of users to negative information, increase the probability of a massive proliferation of misinformation. The design strategies behind digital social platforms affects the way the users' generative model is updated, shaping what stands out as relevant, as well as the reliability of the content being reaffirmed and learned.

Networked spaces are constructed through the imagined collective that emerges from the interaction of users, technology, and practice. The way technology structures these networks reorganizes how information flows and how individuals interact. By introducing new possibilities for interaction, new dynamics emerge that shape participation [boyd, 2011]. An affordance exploiting this is **notifications checking**, (Table 1) which gives users the possibility to tailor the way they receive self-relevant stream-based updates, keeping their attention after every message and event happening in their curated streams. Notifications are at the center of our tendency to be 'connected' all day long and function as a tool to control our fear of missing out relevant information [Giraldo-Luque et al., 2021]. Thus, notification checking affords digital social epistemic actions that lead to gaining self-relevant information, and potential social rewards. This brings about triggered attending on notifications, which guides behavior to engage with digital social platforms. Notifications grab automatically our attention because of their unexpected nature, which gives rise to prediction error. However, the expected rate of prediction error reduction tends to be fast because notifications are self-relevant, crafted to signal important evidence for one's epistemic or pragmatic value. Notification checking allows a fast emotional evaluation of their content. Nevertheless, due to the fact that notifications give small amounts of information, users need to engage with the digital social platform for minimizing prediction error to the full extent.

It is extremely difficult to inhibit the automatic attention directed to the salient visual, auditory, and other properties of notifications [Ward et al., 2017]. Notifications are a particular 'type' of digital stimulus that increase prediction error in an unexpected rate. The uncertainty of the rate at which notifications occur increases the rewarding experience, and the resulting arousal becomes more highly correlated with reward anticipation. The beeps and buzzes of smartphone notifications, in most cases, provide chaotic patterns of reward anticipation that trigger very strong modes of arousal. In

fact, more dopamine is released when the occurrence of a reward is unexpected than expected [Alter, 2017]. In turn, the intermittent schedule of smartphone notifications promotes stronger anticipations and more compulsive expectations [Veissière and Stendel, 2018]. Moreover, behind the design of digital social platforms and notifications, there is another tweak that works for maximizing engagement. Users' learn how to change the rate at which notifications might occur as product of their digital social interactions. For example, when sharing an image, a phrase, or commenting in a friends' posts, users' expect an increase in notifications and in a faster rate. In digital social platforms, users' have shared expectations about the rewarding consequences of being engaged in digital social interactions. By means of enacting a digital social affordance, users' tend to expect notifications which are strongly associated with a social reward, but due to the fact that the precise moment of its occurrence is still uncertain, the triggered attending and the rewarding experience are enhanced.

Notifications are designed to direct attention as they contain repetitive, but novel and affective information [Giraldo-Luque et al., 2020]. When notifications are particularly salient, or emotionally rewarding, an engagement with the digital social platform becomes 'irresistible'. If the outcome of a notification is the one expected, gaining more information about it, it is by itself rewarding, and its associated pragmatic value increases the precision of the policy that led to that outcome. However, if the outcome of a notification is not the one expected, the resulting prediction error and the associated affective disappointment also induces an engagement with digital social platforms [Veissière and Stendel, 2018]. In both cases, an expected or unexpected outcome, the digital social epistemic action that leads to an engagement with the digital social platform will tend to be associated with an extremely fast rate of error reduction. In the former case, users' expect to gain information associated with an expected social reward. Usually, users' intentions when checking the content of a notification just aim to gain more knowledge about it, but as the interaction with the platform starts, new digital solicitations stand out as relevant increasing the time spent on it. In the latter case, usually, users' expect to find other digital social affordances to stand out as relevant to deal with affective tension. Indeed, both cases reflect the main aim behind the design of digital social platforms, maximize engagement and minimize frustration [Alter, 2017].

As it becomes evident, digital social platforms and the design strategies behind them, function as a *superstimulus* because of their trigger functions. Additionally, smartphones connect everything, allowing on-demand access to information, entertainment, social interactions, and so on. Notifications, function as a hub to the connected world. Agents do not have to actively check the network in order to know whether there has been change. While change or validation can be expected, and motivate checking one's social media, trigger notifications automatically grab users' attention. This is a core strategy for maximizing attention because notifications direct your attention to something you did not intend to. In some way, notifications are making the trivial seem urgent, by constantly activating the brain's salience network [of Humane Technology, 2021]. Notifications are automatically interpreted as relevant and salient, but usually they are false alarms that endanger our ability to attend to what is truly important. If a user decides to 'turn-off' notifications, a common strategy behind used by digital social platforms is to suggest or remind the user to keep-up to date by turning on notifications again.

Cultural practices around digital social platforms, such as notifications, have created a dilemma. Notifications function as a tool for staying 'connected' with others, but at the same time they generate a feeling of being compelled to respond and fulfill others' expectations [Pielot and Rello, 2017]. Individuals can feel stressed if they do not reply or respond immediately to the social interactions the notifications are announcing. As in the physical world, in the digital world we have shared expectations of immediate response to others comments or interactions with us. However, in the digital world, the shared expectations of immediate response to others can be overwhelming, but the fear of experiencing social distancing keep us in the loop of notification checking and engagement. The user is thus pushed to update their prior over the source of epistemic and pragmatic value in such a way that digital social information becomes more salient. This is made especially important because the information that is subject to be triggered is salient to the user's social life and self-identity. The outcomes of digital social interactions are also heavily discriminated, as the positive feedback makes an individual feel very good, while the negative feedback makes them feel very bad [Hayes et al., 2016]. Finally, notifications related to digital social platforms are particularly attracting, because of the deeply social nature of the rewards. As a consequence, we can become entrenched in vicious cycles of behavioral addiction that make us crave our smartphones [Veissière and Stendel, 2018], or other technologies at hand for staying 'connected'.

Moreover, immediacy and constant connectedness with others can define our everyday life activities, in such a way that we are accustomed to different forms of monitoring others or cosurveillance [Barassi, 2020]. We are now immersed on a surveillance culture, where the feeling of being constantly observed by others and monitoring others has been normalized [Lyon, 2018]. As a consequence, in the digital way of life, there are shared expectations about being monitored while monitoring others. Digital social platforms afford a constant monitoring of others' activities, their preferences, social interactions, and even to precisely track their location at any given moment. Infinite scrolling and information search are digital social affordances closely related to **Cosurveillance** (Table 1).Cosurveillance affords digital epistemic actions associated to a fast rate of error reduction due to the immediacy by which users can gain

information about others. Thus, this digital affordance provides an instantaneous satisfaction, and an increased sensation of social connectedness which is difficult to achieve at this speed in the physical world. Feeling immediate satisfaction, as the outcome of cosurveillance, increases the quality of this policy. Design strategies such as presenting endless crafted social information, suggesting friends, allowing to see others' list of friends or followers and their timelines, sharing users' current location, as well as crafting notifications about highly salient social information, aim to promote cosurveillance and social interactions to generate more data.

The predictive analytics behind digital social platforms' algorithms, which trace daily digital interactions for reading, profiling, and predicting users' behaviors, can be understood as a type of surveillance capitalism [Barassi, 2020]. Paradoxically, the data by which predictive analytics learn, determining which information is presented to users, is enhanced by the normalization of cosurveillance. Additionally, power relations in digital social platforms are highly complex, because commenting, metavoicing, and gaining followers not only depend on the type of information that is shared, but also on how the structure of the platform is designed for surveillance [Lyon, 2018]. Receiving others' attention in digital social platforms gives a sense of empowerment to users, however, this brings surveillance as a consequence which is not 'transparent' or easy to conceive as such for users. Cosurveillance in digital social platforms, together with our need to be seen, validated, and appraised by others, has been explained by the *hyper-natural monitoring hypothesis* [Veissière and Stendel, 2018]. The hyper-natural monitoring hypothesis suggests that, in digital social platforms, our natural tendencies to be social, monitor others, make social comparisons, occur at a hyper-speed due to the immediacy that smartphones provide. As well as the digital social affordance of appearance changing, cosurveillance also leads to hyper-speed comparisons with others, affecting the way we perceive ourselves by visual normalization. Being constantly exposed to others' best crafted images, which reflect desired social standards, could potentially lead to internalizing maladaptive sociocultural norms [Veissière et al., 2019, Tremblay et al., 2021].

5.2 Digital manipulation of attention

Directing our attention to salient stimuli is evolutionary advantageous [Elam et al., 2010]. Dopamine is closely related to the encoding of surprising or salient events because of their inherent rewarding nature related to information gain valuable for adaptive behavior [Diederen and Fletcher, 2021]. As discussed so far, digital social platforms take particular advantage of how attentional mechanisms work to increase the likelihood to stay engaged and 'connected' to generate more data and more value. Digital social platforms present surprising and salient information that triggers attention automatically. Additionally, this information is presented in a social context relating it directly to digital social positive and negative rewards. The natural tendency of humans to pay attention to social information, to make comparisons with others, to feel connected with others, as well as the necessity of being socially validated are all exploited by digital social platforms. In this regard, the addictive use of smartphones has been explained by means of the sociality they afford, causing a hyper-social addiction [Veissière and Stendel, 2018].

Algorithms behind digital social platforms are not simply meant to increase users' consumption patterns, they are also meant to create an addiction on the users to increase the time they engage with the platforms [Lanier, 2018-07-15]. Digital social platforms curate and filter information that users are exposed to based on what the algorithms have learned from their online behavior. One of the main important issues for the algorithms is the likelihood the user is going to engage with the information presented. Additionally, they are determining the way digital social interactions can occur, and what is salient, relevant, and socially rewarding. However, it is still a matter of ongoing research whether social media excessive use is an addiction and to what extent it mirrors other addictions [Zendle and Bowden-Jones, 2019]. Here, what we want to highlight is that digital social rewards are particularly salient and attractive because of their ease to occur in comparison to physically situated social interactions. As discussed in section 5.1 due to the way digital social platforms are designed, prediction error minimization is intrinsically facilitated during digital social interactions. If prediction error minimization is rewarding by itself, designing strategies with this aim makes digital social interactions less frustrating, more attractive, and satisfactory than those that occur physically situated. Some of the digital social affordances discussed here, are related to highly precise digital instrumental actions, in such a way that their associated social rewards can be easily fulfilled. Given the close relationship between the precision of an action and dopamine release, highly reliable prediction errors evoke strong dopaminergic responses, leading to better encoding of valuable information for prediction error minimization [Feldman and Friston, 2010]. Additionally, it has been suggested that dopamine plays a central role in signaling a surprising event, in particular, the amount of prediction error associated with a rewarding outcome [Diederen and Fletcher, 2021]. In this regard, all of the digital social affordances discussed here, irrespective of whether they evoke social digital instrumental actions, social digital epistemic actions, or both, seem to be related to a fast expected error reduction rate, which has an impact on precision and how valuable information is encoded.

Digital social platforms present a complex negotiation of digital affordances as well as the underlying culture and norms being cultivated [Cirucci, 2017]. Digital social affordances and their related social digital actions and outcomes reflect

digital shared patterns of attention and encoded shared expectations about what others expect of us and what we expect of others. Although the list could be extensive, these are some examples of digital shared patterns of attention and shared expectations resulting from digital social affordances and enacting digital social epistemic and instrumental actions. On the one hand, digital shared patterns of attention related to self-identity formation encode expectations about 'how we should be', 'how we should look', 'with whom we should relate', 'how can we look or behave to evoke envy or admiration', as well as 'how we should think and behave for saving face' in a specific filter bubble, 'sharing information makes us visible', 'our opinions matter', and 'we have to respond immediately because others matter to us'. On the other hand, digital shared patterns of attention related to belief-updating encode expectations about 'what we believe is correct', 'why the information we search for is relevant and true', 'why it is important that we avoid missing relevant information', 'why the notifications we attend to are relevant', and 'what we monitor about others is allowed because others monitor us'.

Analyzing digital social platforms enables us to pinpoint what is salient for the users, which in turn reveals the encoded values that these platforms are based on. The world-wide popularity of digital social platforms brings us to believe that a more rigorous understanding of the digital affordances they offer and the strategies behind their design is necessary. Similarly, identifying the changes in individuals' self-identity, contexts, and norms that take place when users broadcast their narratives digitally is crucial, given the importance of social media in our everyday lives [Cirucci, 2014]. Although, social media addiction is still a matter of ongoing research [Zendle and Bowden-Jones, 2019], behavioral addiction becomes a social issue when a symptom is affecting at the population level, and it is difficult to accept as it could be seen simply as a new norm [Alter, 2017].

Finally, a great proportion of users accept feeling an internal compulsion that leads to an excessive engagement with digital social platforms, and this compulsive behavior can in part be explained by dopamine-mediated addiction [Lembke, 2021]. In this regard, it seems useful to analyze the compulsive engagement with digital social platforms under a digital manipulation of attention perspective. In other words, we suggest here, that the ease of minimizing prediction error behind the design of digital social affordances could potentially affect the 'optimal-grip', the context-sensitive responsiveness to the field of relevant affordances.

6 'Optimal grip' and digital social affordances

The core idea behind our interpretation of the tendency towards an optimal grip is that the animal in its interactions with the environment will always be drawn to (or attracted by) those action possibilities, the responsiveness to which will improve its situation. The organism, in its dynamical interaction with the environment, forms a far from equilibrium, self-organizing system. The dynamics of this self-organizing process are such that the organism will find itself drawn to affordances that move it closer to equilibrium with the dynamically changing environment (see Bruineberg and Rietveld [2014]). Being poised to respond to an action possibility will only move an animal closer to equilibrium when such a response contributes in some way to an improvement of the animal's overall situation. Think of the boxer moving towards an optimal distance from the boxing bag where the boxer is ready for all possible relevant affordances, it is the random fluctuation of the bag that can determine which action will unfold [Bruineberg and Rietveld, 2014, Rietveld et al., 2018].

In active inference terms, optimal grip is our embodied striving to continually reduce disattunment between internal and external dynamics, which is driven in part by a sensitivity to how well we are reducing disattunment and increasing the motivation to improve. Optimality is never realized for agents like us, and so is never satisfied - there is always room to improve. We explain the tendency (or drive) to improve optimal grip in terms of the monitoring of prediction error dynamics [Kiverstein et al., 2019, Miller and Clark, 2018]. Error dynamics provide embodied feedback for the agent that tells the agent how well it is performing in its skilled engagement with the world, and tend to lead us to opportunities with the optimal level of learnable complexity [Schillaci et al., 2020, Miller et al., 2020a]. The result is that the field of affordances will always be shaped by how well we are gripping and whether we can grip better. We are literally moved through the landscape of affordances by our bodily states of action readiness, which are themselves an expression of how well we are doing at reducing disattunment. And since, as we have already stated, affectivity emerges in part as a reflection of error dynamics, then the field of affordances will also be structured in a way where we are able to stay in touch with our various cares and concerns. In this regard, affective disorders can be analyzed as being closely related to a problem with context relevance-sensitivity, distorting the field of affordances. For example, in depression the field of affordances tends to be flat, that is, nothing stands out as relevant or soliciting, and in obsessive compulsive disorder the field of affordances is narrowed to fixed solicitations, in such a way that the possibility of flexibly switching to new solicitations is lost [De Haan et al., 2013].

The tendency of an individual towards an optimal grip means that it is moved to improve its grip on a specific situation by responding to those affordances that stand out as relevant in that situation (solicitations) [Bruineberg and Rietveld,

2014]. In the field of affordances, this tendency is the product of a dynamic interplay between the landscape of affordances and the current state of the individual. Relevant affordances have to be selected in a context-sensitive manner. Agents have to be selectively open to only the relevant affordances in a particular situation. The structure of the field of affordances changes if the landscape of affordances changes (e.g. environmental changes), or if the interests of the individual change. When an interest is diminished, new relevant affordances show up. The situated anticipation of affordances makes the affordance to stand out as relevant. The tendency towards an optimal grip can be understood as the result of minimizing prediction error through perceptual and active inference. When the generative model and the environment are well synchronized, the relevant solicitations and the prediction errors are those that lead towards an optimal grip on a particular situation [Bruineberg and Rietveld, 2014].

The richest opportunities for improving our predictive grip will come from affordances that are neither too complex, nor too simple that we already know how to exploit and make the most out of them. Various lines of research support the view that agents like us (and lots of other intelligent animals) actively seek out environments with optimal amounts of prediction error or complexity (see Kidd et al. [2012], Stahl and Feigenson [2015], Berlyne [1966]; and for an implementation of this idea in robotics see Schillaci et al. [2020]). A system that is affectively tuned to changes in the rate at which prediction error is minimized will naturally find itself attracted to those opportunities where the most prediction error can be reduced. When this process is working well, these affective dynamics keep us in contact with those spaces that have optimal complexity, and where we can maximize our learning rates. It is these same affective dynamics that are hijacked by compulsive behaviors and addictive substances, including the hyper-stimulating effects of many digital social platforms.

The fields of offline cultural affordances, of online digital affordances, and of digital social affordances (see Fig. 1) dynamically emerge in a context-sensitive manner from the total landscape of affordances. However, as discussed in section **??** our field of affordances is moving towards solicitations related to digital social affordances. Given the way affordances are designed in digital social platforms, users will naturally find themselves attracted to the fast rate of error reduction these affordances provide. Thus, if users are affectively tuned to changes in the rate at which prediction error is being reduced, digital social affordances have the potentiality to become highly salient in the field of affordances. In this regard, three dimensions in the dynamic field of affordances have been proposed [De Haan et al., 2013]. First, the 'height' is closely related to the motivation of an individual because it represents the relevance and salience of the affordances to which an individual is particularly responsive because of its affective attractiveness. Second, the 'width' is related to the broadness of the scope or the diversity of choices in action possibilities. Third, the 'depth' refers to the temporal domain of affordances in terms of the future possibilities for action that an individual is pre-reflectively aware that could be present in a given moment and that she is responsive to. Here, we suggest that the three dimensions of the field of affordances proposed by De Haan et al. [2013], can help to make a phenomenological characterization of a digital way of life.

In Fig. 3 the three dimensions of the field of offline cultural affordances and digital social affordances are represented. In the field of offline cultural affordances, the affordances' dimensions of 'width', 'depth', and 'height' are diverse and they are also associated to a variety of expected rates of error reduction. This illustration aims to show the inviting character of multiple affordances in a given situation, as well as how our affective dynamics will naturally attract us to those affordances that have optimal complexity for learning and for being attuned to the environment. On the contrary, in the field of digital social affordances, although they vary in 'width' and in 'depth', the affordances' 'height' is very similar and also overall pronounced. Additionally, the associated expected rates of error reduction are equally fast. Thus, this illustration highlights how in the field of digital social affordances the inviting character of multiple affordances is highly salient and full of affective attractiveness. Given that the salience of affordances is closely related to motivation, and that digital social affordances are associated with a fast rate of error reduction or opportunities with the optimal level of complexity, individuals will naturally find themselves attracted to these affordances. When enacting a digital social affordance, the embodied feedback of error dynamics will signal an optimal grip with the environment and a positive valence will emerge as a product of experiencing a skilled engagement and attunement.

In the digital way of life multiple affordances from the physically situated environment and from the digital environment are competing. How strongly a solicitation invites an engagement with an action depends on the current skills of an individual, the task with which she is engaged, and on the demands of the current context [Bruineberg and Van den Herik, 2021]. However, the highly salient nature of digital social affordances has the potential risk of shrinking the field of relevant physically situated affordances (i.e. offline cultural affordances). Analyzing digital social affordances enables us to ask how the digital way of life we are immersed in now could be changing our context-sensitive responsiveness to the field of affordances. A great number of our daily activities are performed online, so we are constantly engaged with digital tasks and immersed in a digital context. In this regard, if the environment changes, the field of relevant affordances also changes, and to the same extent, if the individual concerns change the salience and relevance of the available affordances change [De Haan et al., 2013]. Therefore, does the 'width' of the physically situated affordances is narrowing down, or is it just shifting towards digital affordances? Does the 'depth', the anticipatory affordance-

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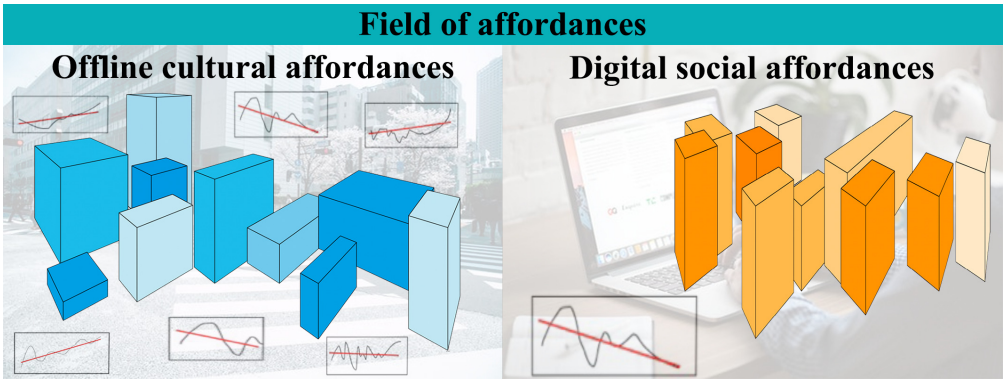

Figure 3: Schematic representation of the three dimensions of the field of affordances in a digital way of life. Taking these dimensions, 'height', 'width', and 'depth', a comparison between the offline cultural affordances and the the online digital social affordances is made, considering their expected rate of error reduction and affective attractiveness as action-readiness in the field of affordances.

responsiveness, is becoming biased towards social digital possibilities of action? Does the 'height', the inviting character of multiple digital social affordances, is constantly increasing the responsiveness to digital social interactions? Does the ease to minimize prediction error in digital social platforms is narrowing down the focus towards digital social rewarding opportunities? Does being constantly 'connected' to digital social platforms is changing the relevance and affective attractiveness of physically situated affordances? How can the context relevance-sensitivity to affordances be distorted as a consequence of excessive use of digital social platforms?

A pathologically high precision on a particular policy can create an imbalance (and indeed a collapse) in the field of affordances. Repeated behaviors related to dopamine release can be thought of as training expectations about the rate of error reduction. In effect, being attracted to compulsively repeat a particular policy associated with dopamine release make us feel as if the body is getting into the states it needs to be in given the brain's model of the world. This on its own does not lead to pathological behavior, instead it is the consistently revisiting the physiological states that rapidly reduce prediction error that becomes the sole and exclusive driver of behavior. In time, environmental cues that lead to behaviors full of affective attractiveness come to inform the system that a tremendous reduction in disattunment is about to occur. This prediction is given high precision, which means that it comes to drive the action-perception cycles related to highly rewarding behaviors. The higher the precision of such action-perception cycles the more fiercely the system is driven to bring them about. The organism quickly learns that nothing else can reduce disattunment in such a drastic fashion. Once this level of disattunment reduction is predicted, the system can only be satisfied by compulsively engaging with the dopamine-related particular policy. Other opportunities for lesser reductions in disattunment are increasingly ignored, or their precision is constantly diminishing. If the state is withheld, the difference between the highly expected and profoundly satisfying state and the current state equals the level of dissatisfaction.

Digital social platforms provide endless opportunities for being engaged with highly rewarding behaviors associated with a fast error reduction rate. Highly rewarding behaviors hijack our sensitivity to error dynamics, leading the system to self-organize in ways that run counter to continued thriving. Over time, as these ways of self-organizing are increasingly over learned the compulsive behavioral dispositions are enacted more and more consistently, produced by a greater and greater number of highly rewarding behavior-related cues, while other opportunities for rewarding behavior are increasingly muted. In ecological terms, we can understand this as the gradual collapse, or shrinking, of the field of affordances. The very same mechanisms that produce curiosity and exploration once hijacked by the highly rewarding behaviors produce precisely the opposite effect. Instead of being moved to pursue the multiple possibilities we care about, the hijacked learning system leads the person to engage with the world in tighter and tighter circles of compulsive behaviors.

We suggest that the ease to minimize prediction error when engaged with digital social affordances might help to understand the compulsive use of digital social platforms, making users feel like they are well-attuned even though most of their awake daily time they are not. Digital social platforms create an illusion of attunement to the environment. They do so by making it seem to the user as if they are improving their predictive grip and reducing their overall disattunment. As we are constantly 'connected' and our cellphones are increasingly being part of our extended cognition, the immediacy of accessing to highly rewarding behaviors in digital social platforms has the power to 'cheat' the multiple affordance competition. The design behind digital social affordances directs the whole predictive organism to track and engage with signals that register in the brain as highly valuable in terms of adaptive success, but are in

fact precisely the opposite. No skills, relationships, or resources are gained or improved. And in long term addiction, other important life concerns such as physical and mental health, relationships and career often suffer. This further perpetuates the cycle that collapses the field - as more and more error from the many negative effects of compulsive behavior incur, and less and less skillful development and support is achieved, the individual turns once again to the compulsive behavior as a means of temporarily experiencing the illusion of tending towards an optimal predictive grip.

7 Discussion

In this paper we have surveyed the literature on digital affordances [Hayes et al., 2016, Wohn et al., 2016, Karahanna et al., 2018] and analyzed different types of digital social affordances under an active inference view, placing them into two categories, those for self-identity formation, and those for belief-updating. Although each of the analyzed digital social affordances allows different epistemic and instrumental digital actions, they all share the characteristic of having an "easy" and a fast expected rate of error reduction. Effectively, minimizing prediction error and with this obtaining a positive valenced error reduction rate, becomes easier when engaged in digital social affordances in comparison to geographically situated affordances. Here, we aim to provide a new hypothesis about how the design behind digital social affordances is built on our natural attractiveness to minimize prediction error and the resulting positive embodied feelings when doing so. When engaged with a digital social affordance, the embodied sensitivity to how well and fast prediction error is being minimized will continuously signal to the individual a tendency towards an optimal predictive grip [Bruineberg and Rietveld, 2014], in the local context of social media [Stronge et al., 2015, Liu et al., 2018]. .

Under an active inference view behavioral decision-making, the selection of an action and its disengagement, is for prediction error minimization [Friston et al., 2012a]. Expected prediction error associated to epistemic and instrumental actions in a given context guides decision-making depending on whether prediction error is precise or relevant, as well as if the related prior belief is assigned with a high or low confidence [Kruglanski et al., 2020]. Additionally, and of particular relevance here, behavioral decision-making, also depends on the experienced embodied feelings resulting from the monitoring of prediction error dynamics over time, that is the sensitivity to the rate of error reduction manifested as changes of affect [Miller et al., 2020b]. The rate of error reduction plays an important role in tuning precision estimations of an action policy in such a way that if the speed of error reduction is expected as fast or occurs even faster than expected the action policy will be weighted as having a high precision. Thus, attention will be directed to those actions related to precise beliefs over rewarding outcomes, and those actions that can potentiality lead to gain information will become salient, increasing the probability that they will be enacted [Parr and Friston, 2017]. Under this view, the expected fast rate of error reduction associated with digital social affordances makes digital social platforms a technological tool highly attractive for users. Here, we suggest that digital social platforms take advantage of how precision weighting occurs, and how precision expectations are tuned to context-based embodied feelings that aim to improve our skillful engagement with the environment.

The hypothesis that is suggested here highlights a digital manipulation of attention based on prediction error minimization. This manipulation aims to constantly increase the time users spend on digital social platforms, in order to generate more data and more value for the benefit of third-parties interests. Contrary to digital social platforms, culture manipulates our attention by efficiently directing our resources for prediction error minimization towards what is salient and relevant in a social context [Heras-Escribano and De Pinedo-García, 2018, Miller, 1984, Constant et al., 2019]. In digital social platforms attention is being manipulated by third-parties which seek to entice the individual [Gearhart and Zhang, 2015, Cirucci, 2017, Kumar and Shah, 2018, Giraldo-Luque and Fernández-Rovira, 2021], rather than for signaling accurate and relevant information about the world. We believe that analyzing the digital manipulation of attention based on prediction error minimization could help to explain how a compulsive engagement with digital social platforms may occur, and why this compulsive behavior could potentially affect the context-sensitive responsiveness to the field of relevant affordances.

The extensive overview of digital social affordances, has allowed us to link the growing technological landscape to natural phenomena. Specifically, we have seen how the individual is drawn to digital social platforms because they allow them to take part in cultural scripts [Albarracin et al., 2021], or shared regimes of attention [Constant et al., 2019], and receive rewards for this engagement [Chua and Chang, 2016]. Additionally, we discussed how digital social platforms are changing the patterns of attention, affecting the way beliefs are updated, how social norms are learned, and how self-identity is built. The learned digital shared patterns of attention reflect our encoded shared expectations about what others expect of us and what we expect of others during digital social interactions. In this regard, individuals are also drawn to the platforms because they allow them to craft personas which are broadcast to curated audiences [Wohn et al., 2016], reinforcing an image of themselves they could not achieve in real life [Tremblay et al., 2021]. Through a mix of epistemic value and confirmation bias, individuals feel like they have much to gain by tending to social media [Albarracin et al., 2022].

Digital social platforms use has become an extension of life and, to some extent, a collective belief has been generated about the need to use them in order to 'exist', in such a way that social acceptance depends on socializing with others in trending digital spaces [Boyd, 2014]. However, it is important to keep in mind that social media platforms can easily hijack cultural processes in order to maximize profit without taking into consideration the potential harm of their users [Kim, 2017, Deb et al., 2017]. This hijacking has unfortunate potential consequences for our attentional processes and capacity to allocate epistemic value. By its very nature, social media promotes the creation of content [Wang and Li, 2014]. Through the meta-linguistic processes of likes and sharing, agents on social media benefit from expressing their views as they will be rewarded by signals of social attention Hayes et al. [2016]. The degree to which they receive attention also signals to them the degree to which they have optimal grip on this social setting [Stronge et al., 2015, Liu et al., 2018].

Here, we aim to provide a new hypothesis about how the design behind digital social affordances and the excessive use of digital social platforms might affect an optimal grip to the environment, that could foster research in this direction. However, we want and must be very careful that this hypothesis is not interpreted as a dystopian view of technological determinism [Heilbroner, 1994]. The dystopian view assumes that when a specific technology is broadly adopted it will transform society in terrible ways that will ruin everything [Boyd, 2014]. Even though, some evidence points to a causal link between decreasing social media use and an improvement in feeling less lonely and depressed [Hunt et al., 2018], other findings suggest that there is no clear evidence of this causal link and that the relationship between depressive symptoms and digital social platforms use is complex [Heffer et al., 2019]. Nevertheless, it is important to keep in mind that the main aim of digital social platforms is capturing the user's attention for economical purposes [Giraldo-Luque et al., 2020].

It is important to consider that bad habits related to the excessive use of digital social platforms are not just the product of the digital manipulation of attention. Undoubtedly, further research is needed to avoid just blaming and generalizing the use of any digital social platform for problems related to well-being and mental health without considering other factors. In this regard, cultural, social, and contextual factors of an individual need to be considered, such as school achievement, family environment [Boyd, 2014, Paakkari et al., 2021], emotional regulation abilities [Hormes et al., 2014] among others. Self-regulation of behavior is a key component for finding balance [Bandura, 2005, LaRose et al., 2003], and more so in a constantly 'connected' society [Felt and Robb, 2016]. Increasing awareness of the use of digital social platforms can help individuals question how much of their daily time is spend 'connected' in comparison with the time they spend engaged with the offline physical world, and how comfortable they feel with this comparison.

In conclusion, digital social platforms are trading with prediction error minimization for our attention. Designing digital social affordances, which allow an "easy" and a fast rate or prediction error reduction, will keep our attention to generate more data, and more and more value. The field of digital social affordances is becoming more and more salient as attentional manipulation increases. Digital social platforms, are now the equivalent of what situated social places were, raising the level of responsibility around digital social communities, companies and platform moderators [Odgers and Robb, 2020]. Finding out the best solution to this concern is complicated. However, we hope to encourage further research on the matter for greater clarity on how attentional patterns are changing as a consequence of third-parties economical interests, as well as how individuals' well-being is being affected and then create public policies in this regard.

Additionally, more research is needed to understand how digital-related affordances are changing social ontology, norms, assumptions, and everyday practices that shape our way of life. Digital social platforms' use has become an extension of life. Instead of focusing in the usefulness of digital social platforms, that somehow is undeniable, it could be more fruitful to understand how this digital way of life is creating a new adulthood [Fu and Cook, 2020], and possibly, with very different patterns of attention.

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