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Integrative well-being leads our attentional system: An eye-tracking study

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Abstract

Both hedonic and eudemonic components of well-being have been related to different variables such as mental and physical health, or social and economic factors. However, and despite the growing interest in the study of well-being, there is scarce evidence on the role that these components play in high cognitive processes such as attentional deployment towards emotional information. The aim of the present study is to disentangle the relation between current affect (state hedonic well-being), integrative well-being (i.e., hedonic, eudaimonic and social well-being), and attentional biases towards emotional information.

Participants (N = 119) performed and eye-tracking task where they were asked to freely watch a series of 108 pairs of faces depicting happy, sad or neutral expressions in three types of conditions (i.e., happy vs. neutral, sad vs. neutral, and happy vs. sad faces). Results showed that both current affect and integrative well-being were associated with a maintenance attentional bias towards positive information (i.e., happy faces). Further, using bootstrapping mediation analysis, we found that the relation observed between current affect and positive maintenance attentional biases was totally mediated by integrative well-being levels. We discuss the relevance of the present results in the incipient research on cognitive and emotional processes and well-being.

Key words: Affect; integrative well-being; emotional faces; attentional biases; eye-tracker.

Introduction

Psychological well-being is a condition characterized by having beliefs of living a fulfilled life and a state where the frequency or intensity of positive emotions prevail over negative ones (Diener, 1984; Ryff, 1989). There is already a vast amount of literature on the determinants of those eudaimonic and hedonic components of well-being. Research has found that, for instance, social and economic factors (Oishi, Kesebir & Diener, 2011; Diener & Seligman, 2018) are significantly related, both at the individual and community level, with well-being. Likewise, individual factors such as age (Laaksonen, 2018), gender (Arrosa & Gandelman, 2016), personality (Zelenski et al., 2013), genetics (Bartels, 2015), or physical and mental health status (Vázquez, Rahona, Gómez, Caballero, & Hervás, 2015), to name a few, have been found to be associated to personal well-being.

Despite the growing literature on the basic components participating in the construction of emotions (Lindquist, 2013), there is relatively scarce research on the basic cognitive mechanisms (e.g. attention, memory, or perception) underlying hedonic or emotional well-being and eudaimonic well-being (Robinson & Eid, 2017). The case of attention is particularly interesting. Current theories of emotion regulation state that a key component of the processes leading to effective emotion regulation is an adequate deployment of attention strategies (Gross, 2013). For instance, Sanchez, Vazquez, Gomez & Joormann (2014) found that participants who, after a negative mood induction, automatically deployed their attention towards positive information (i.e. happy faces) recovered their mood faster than those who spent more time looking at other types of stimuli (i.e. sad or neutral faces). Thus, the act of paying attention to specific aspects of the present information, which is a process that is prior to the appearance of emotional

responses, may contribute to reduce distress and increase well-being (Ochsner & Gross, 2005; Urry, 2010).

There is also evidence from other areas of research that, indirectly, supports the hypothesis of a close relation between well-being and attentional deployment. For instance, it is well known that the ability to select attentional targets, and to maintain or withdraw our attention from them, whether consciously or not, is associated to the onset and maintenance of a number of emotional difficulties (Sheppes, Suri & Gross, 2015). Also, there is ample evidence that depression, a condition that has the highest cost in terms of happiness and life satisfaction (Vazquez et al., 2015; Bergsma, ten Have, Veenhoven, & de Graaf, 2011; Fuller-Thomson et al., 2016), is associated with difficulties to engage with positive information (Armstrong & Olatunji, 2012; Duque & Vazquez, 2015). Yet, findings on attentional deployment and distress provide only indirect evidence of the association between attentional mechanisms and well-being and more research is needed to disentangle the role that attentional processes plays in psychological well-being.

In a seminal study, Fredrickson & Brannigman (2005, Study 1) assigned participants to watch film clips with positive, neutral, or negative scenes as a procedure to induce the corresponding moods. Then participants completed a perceptual task to assess global versus local visual preference. Fredrickson & Branningman (2005) found that a positive emotional state favored a more global perspective of the presented stimuli and interpreted their findings as a demonstration that positive emotions broaden the scope of attention which, in turn, leads to improving individuals' cognitive and behavioral adaptive repertoires (Chaves, Hervas, Garcia, & Vazquez, 2016). Other authors have proposed that it could be possible that positive emotions, rather than automatically expand or shrink the attentional focus, may modulate this focus thereby allowing flexible and adaptive coping

strategies in different environments (Vanlessen, de Raedt, Koster & Pourtois, 2016). In any case, this debate shows that there is an increasing awareness of the complexity between positive emotional states and well-being, and that the relationships between attention and well-being are still far from being fully understood. In fact, the concept of psychological well-being is complex as it includes different components (e.g. hedonic and eudaimonic) but also different temporal perspectives (e.g. states vs traits). Although most of the incipient research on the analysis of cognitive components of well-being has been done studying emotional states (e.g. current emotions using list of adjectives), some recent studies have explored attentional performance linked to trait or dispositional happiness. For instance, Grafton & MacLeod (2017), using a dot-probe paradigm with positive and neutral word pairs, found that participants high in a trait of positive affectivity showed an attentional bias towards positive words, whereas those participants low in that positive trait showed an attentional bias towards neutral words. These results have also been confirmed using more direct measures of attention via eye-tracking paradigms. Raila, Scholl, & Gruber (2015) found that higher levels of dispositional happiness (i.e. overall feelings of being a happy person and being satisfied with life) was associated with spend more time looking to positive images (compared to neutral ones) even when current positive and negative affect were controlled. Therefore, experiencing dispositional positive emotions seem to lead to preferential attention to positive information.

Despite of this body of research regarding well-being and attentional patterns, there is a scarce of evidence regarding the relations between different components of well-being and attention to emotional information. In a first attempt to explore these components, Sanchez & Vazquez (2014) used mediational models to assess the role of different components of subjective well-being on attentional performance. Specifically, the authors

assessed participants' hedonic state (i.e. positive and negative affect) and their overall appraisal on their satisfaction with life, both of which characterize subjective well-being (Diener, 1984), on attentional biases. These authors found that the relation between life satisfaction and attentional biases towards positive information was mediated by positive affect, even after controlling the influence of negative affect. This study, based on a mood-congruent framework (Bower, 1981), suggested that life satisfaction promotes the experience of positive emotions which, in turn, facilitate the attentional processing of positive information (Sanchez & Vazquez, 2014). However, this previous research has only addressed the influence of measures of 'subjective well-being' (Diener, 1984) -i.e. positive and negative emotions and life satisfaction- without considering the role of other elements of well-being related to flourishing (e.g., eudaimonic or social well-being variables). To date, there is no study directly addressing the relation between a more integrative measure of well-being, that incorporates not only hedonic but also eudaimonic and social well-being components, on attentional processing of emotional information. Therefore, the aim of the present study was to explore these relations."

The study also aimed to improve previous methodologies in two directions. First, it includes, in the same study, measures of both subjective and psychological well-being. This distinction might be relevant in the study of cognitive processes as there is abundant data showing that these two types of measures tap different constructs and correlate with different types of outcomes (Diener, Kahneman, Tov, & Arora, 2010). The second improvement over most of previous research is the use of eye-tracking methodologies, which are considered a direct measure of attention without the limitations of measurements based on reaction times (Vazquez, Blanco, Sanchez, & McNally, 2016). to our knowledge, previous research has only compared attentional patterns, and their relation to well-being

when emotional information is presented along with neutral information for participants' attention. In our study, we simultaneously presented happy and sad faces competing for participants' attention. The use of these more demanding stimuli (i.e. simultaneous presentation of positive and negative information) was expected to shed light on the influence of well-being of attention preferences in more complex and ecological contexts (Blanco et al., 2019). Also, the present study tried to overcome some limitations of previous research such as the control of low-level features of the stimuli (see Blanco, Serrano-Pedraza, & Vazquez, 2017; Raila, Scholl. & Gruber, 2015). In conclusion, through the use of mediational models, the aim of the present study was to disentangle the relation among global well-being, current affect, and attentional biases towards emotional information.

Following broaden-and-build theory (Fredrickson, 2001, 2004), we hypothesized that feeling positive emotions would enhance more stable evaluative components of well-being (i.e. integrative well-being) which would lead to attentional biases towards positive information. Therefore, we predict a mediational model on which integrative well-being would mediate the relation between positive affect and attentional biases towards positive emotional information.

Method

Participants

A total of 119 undergraduate students took part voluntarily in the present study in exchange of course credits or monetary compensation (10€). Nine participants (7.56%) were excluded from this original sample due to unreliable eye-tracking data (defined as more than one third of the trials with less than 80% of eye-tracking signal; Raila, Scholl & Gruber, 2015; Lewis, Blanco, Raila & Joormann, 2019). This resulted in a final sample of

110 participants (81 female, 29 male) with a mean age of 21 years (*SD* = 2.33). All participants had normal or correct-to-normal vision.

Materials

Psychological Measures

The Positive and Negative Affect Schedule (PANAS –Watson, Clark, & Tellegen, 1988) was used to assess current positive and negative affect immediately before to the experimental task. This schedule is composed by 20 adjectives (10 negative, 10 positive) on a 1 ("not to all") to 5 ("extremely") Likert scale. In the current study, the reliability was good both for both the Positive Affect (PA) factor (α = .89) and the Negative Affect (NA) one (α = .84).

The Pemberton Happiness Index (PHI – Hervás & Vázquez, 2013) was used to assess integrative well-being (IWB). This is an 11-item questionnaire that provides a composite index of integrative well-being. The questionnaire includes two items related to life satisfaction and vitality *("I am very satisfied with my life"; "I have the energy to accomplish my daily tasks"*), six items covering eudaimonic well-being (i.e.,. life meaning - *"My life is full of learning experiences and challenges that make me grow"*; self-acceptance - *"I feel very connected to the people around me"*; personal growth - *"My life is full of learning experiences and challenges that make me grow"*; relatedness - *"I feel very connected to the people around me"*; perceived control - *"I feel able to solve the majority of my daily problems"*; autonomy - *"I think that I can be myself on the important things"*), two items of trait-like hedonic well-being assessing the frequency of positive and negative affect in daily life (i.e., *"I enjoy a lot of little things every day"; "I have a lot of bad moments in my daily life"*), and one item of social well-being (*"I think that I live in a society that lets me fully realize my potential*"). Therefore, the PHI can be considered an

integrative measure of well-being covering different components of subjective, psychological and social well-being. Also, contrary to the PANAS version used in this study, which measures current affective state, items are framed with no specific time window. Participants are asked to respond using a scale from 0 (totally disagree) to 10 (absolutely agree). The reliability on this study was very good ($\alpha = .92$).

Stimuli and apparatus.

A total of 54 faces (18 happy, 18 sad, 18 neutral) were selected from the Karolinka Directed Emotional Faces database – KDEF (Lundqvist, Flykt, & Öhman, 1998). The sex of the models was balanced (9 male, 9 female). The final set of stimuli comprised 36 pairs of emotional faces and their corresponding neutral paired face from the same actor or actress. All the pictures were converted to grey scale and non-informative areas (i.e. hair, neck, ears) were cropped. Additionally, the teeth of happy faces were blurred, by a grey Gaussian-type filter, to avoid the influence of teeth visibility in participants' attentional patterns (see Blanco, Serrano-Pedraza, & Vazquez, 2017).

Participants' eye-movements were recorded using a Tobii Tx-120 infrared eye tracker at a frequency of 120 Hz. Participants were seated in an anatomic chair with a distance of 60 cm between their eyes and the eye-tracker system. Gaze calibration was done for each participant before starting the session. Stimuli presentation and eye tracker assessment were controlled with Tobii Studio Software (2.0.6).

Procedure and attentional task

After signing the informed consent, participants completed the self-report questionnaires. Immediately afterwards, participants carried out the eye-tracking task. The

eye-tracking task consisted in 108 free-viewing trials (36 happy vs. neutral - HN; 36 sad vs. neutral - SN; 36 happy vs. sad - HS). Each trial began with a grey screen for 500ms followed by a white fixation cross displayed in the center of the screen (500ms). Thereafter, a random number (from 1 to 3 and from 7 to 9) appeared replacing the fixation cross (1000ms). Participants were asked to say the number aloud, as quickly as possible, to ensure that they were looking at the center of the screen (Calvo & Avero, 2005). Immediately afterwards, a pair of competing faces (HN, SN or HS) were displayed for 3,500 ms. Participants were asked to freely look at the faces without any constrain. Each emotional face was presented equally and its position on the screen (right or left) was counterbalanced. The entire procedure lasted for approximately 15 min.

Eye-tracking data filtering

Eye-tracking reliability signal was analyzed as a relative percentage of the stimuli duration (3500ms) and the time that each participant spent fixating their gaze and doing saccades (i.e. dwell time) in the screen area. Thus, dwell time on the entire screen for each trial and each participant was calculated. Only those participants with more than 80% of the time looking and making saccades at the screen area on more than two thirds of the trials were included in the analysis (Raila, Scholl & Gruber, 2015; Lewis et al., 2019).

Attentional measures

As the aim of our study was to assess the relation between current affect and integrative well-being and attention, in our analysis we used the total time that participants spent doing fixations (i.e. Total Fixation Time - TFT) on each emotional face. TFT is a measure of attentional maintenance, which is the parameter more frequently found to be

associated to well-being variables (see Raila, Scholl, & Gruber, 2015; Sanchez et al., 2014; Sanchez & Vazquez, 2014).

Further, and following Shane & Peterson (2007) guideline, we computed a relative TFT bias for each pair of faces by subtracting the TFT on neutral faces from the TFT on emotional faces (happy or sad) in the HN and SN conditions. For the HS condition, we subtracted the TFT of the sad faces from the TFT of the happy faces. Therefore, a positive value in the HN and HS condition indicate a positive attentional bias (i.e. an attentional maintenance bias on the positive face of the pair), whereas in the SN condition a positive value represents a negative attentional bias (i.e. an attentional maintenance bias on the negative face of the pair).

Results

Relations between affect, integrative well-being and maintenance bias.

A series of zero-order Pearson correlations were calculated to analyze the relations between current positive affect (PA) and negative affect (NA), integrative well-being (IWB) and maintenance attentional bias scores to each pair of faces.

As shown in Table 1, our results showed that both PA and NA were significantly associated with IWB but in the opposite direction (r = .508, p < .001; and r = -.234, p = .014, respectively). Regarding the relations between PA and IWB and attentional biases, results showed that both were positively associated with a positive maintenance bias to happy faces on both HN and HS trials (all p < .011). Regarding NA, this type of affect was negatively associated to a positive maintenance bias to happy faces on both HN and HS trials (both p < .006). Also, IWB was negatively associated to a negative maintenance bias to sad faces on SN trials (p = .016). However, PA and NA were not associated with the negative maintenance bias to sad faces on SN trials. (see Table 1).

Bootstrapping mediational analyses

A series of bootstrapping mediational analyses were carried out to analyze the role that current affect (i.e. PA and NA) and IWB play in relation to attentional maintenance biases towards emotional faces. We analyzed the indirect effects of mediational models to assess whether PA or NA predicted attentional maintenance biases through its relation to IWB. Also, we analyzed the alternative model (i.e. whether IWB predicted attentional maintenance biases via its influence on PA or NA). Following Mallinckrodt, Abraham, Wei and Russel (2006), firstly we used a bootstrapping mediational analysis to estimate the relation between the predictor and the mediator variables (path *a*), the relation between the mediator and the criterion variables (path *b*), and the relation between the predictor and the criterion variables (path *c*). Secondly, we assessed the relation between the predictor and the criterion variables when the mediator variable was controlled (path *c'*). Finally, the true indirect effect (*a* x *b*) was analyzed. We employed a 5000 bootstrap resampling method with a 95% confidence interval (Hayes, 2013). An 8-digit confidence interval was used to assess all the direct and indirect effects of the models. Additionally, we also tested all the models using both PA and NA as covariates to take into account the relation of both aspects of emotional affect.

We conducted these analyses only for those conditions (i.e. Happy vs. Neutral; and Happy vs. Sad) in which attentional biases were associated with all the components (i.e. PA, NA, and IWB)[1].

[1] In the section below, we only report the mediational model for the Happy vs. Sad condition as the same results were found for the Happy vs. Neutral condition (see supplementary material for the mediational models for Happy vs. Neutral condition).

Mediational models of maintenance bias on Happy vs. Sad trials.

a) Current Affect→ IWB→ Positive attention bias

In the first set of mediational analyses, Affect was introduced on the model as the predictor variable, positive maintenance bias to happy faces as the criterion variable, and IWB as the potential mediator.

Our results showed that PA significantly predicted IWB (path *a*; IC = .76590764; 1.49768517) and the positive maintenance bias to happy faces (path *c*; IC = .00427600; .03240297). Further, when IWB was entered on the model as a mediator, it also significantly predicted the positive maintenance bias to happy faces (path *b*; IC = .00183059; .01615402) but PA did not (path *c'*; IC = -.00778929; .02411333). This revealed a true indirect effect of IWB (*a* x *b*; IC = .00299833; .01868420). Thus, since zero was not in the 95% confidence interval and PA no longer predicts positive maintenance bias to happy faces, when IWB was introduced as a mediator, our results showed that IWB totally mediate the relation between PA and the positive maintenance bias to happy faces (see Table 2). Furthermore, the same total mediation model resulted when NA was introduced on the models as a covariate.

Regarding NA as the predictor variable, our results showed that negative affect also significantly predicted IWB (path *a*; IC = -.167999671; -.19633264) and the positive maintenance bias to happy faces (path *c*; IC = -.06221517; -.01211925). Further, when IWB was introduced as a mediator on the model, both negative affect (path *c'*; IC = -.05346783; -.00364020) and IWB (path *b*; IC = .00295382; .01540798) significantly predicted the positive maintenance bias to happy faces. Additionally, a significant indirect effect of IWB emerged (*a* x *b*; IC = -.01919798; -.00205372). This, revealed that IWB

partially mediated the relation between negative affect and the positive maintenance bias to happy faces (see Table 2). Finally, the same partial mediation model resulted when PA was introduced on the models as a covariate.

b) IWB →Current Affect →Positive attention bias

In the second set of mediational analyses, the alternative model (i.e. Affect as a potential mediator between IWB and the positive maintenance bias to happy faces on happy vs. sad trials) was tested.

The pattern of results showed that PA did not significantly predict the positive maintenance bias to happy faces (path *b*; IC = -.00778929; .02411333). Only IWB significantly predicted both PA (path *a*; IC = .15438970; .3018995) and the positive maintenance bias to happy faces (path *c*; IC = .00468608; .01702278). Thus, no indirect effect emerged with PA as a mediator. Regarding NA as a potential mediator, both negative affect (path *b*; IC = -.05346783; -.00364020) and IWB (path *c*; IC: .00423446; .01540798) significantly predicted the positive maintenance to happy faces. However, the indirect effect did not emerge since the zero criterion lied on the interval confidence (*a* x *b*; IC = -.00004355; .00579611). Therefore, neither positive nor negative affect played a role of mediation between IWB and maintenance bias to happy faces when presented with sad faces. (see Table 3).

Discussion

The aim of the present study was to contribute to the disentanglement of the relation between different components of well-being and attentional biases towards emotional information. We analyzed, using mediational models, the relation among current hedonic (i.e. current affect), integrative well-being and attentional patterns when processing emotional faces. Following Fredrickson's broad-and-build theory (2001, 2004) it was hypothesized that the influence of current affect on attentional patterns would be mediated by more global representations of well-being. Fredrickson's theory posits that feeling and experiencing positive emotions build and broad other emotional and cognitive resources such as attention or resilience. Our results fully supported our hypothesis. Specifically, results revealed that integrative well-being totally mediated the effect of positive affect on the positive maintenance bias when both positive and negative (and positive and neutral) emotional information is being processed simultaneously.

Previous research had found that positive mood is associated with attentional biases towards positive information (Tamir & Robinson, 2007). For instance, using mediational models, Sanchez & Vazquez (2014) found that although both a positive evaluation of one's own life (i.e. life satisfaction) and currently experiencing positive emotions led to attentional biases towards positive information, mediational analyses revealed that positive emotions fully explained the relation between life satisfaction and attentional performance. Thus, the role of life satisfaction seemed to be negligible in explaining positive attentional biases. Based on a mood-congruent framework (Bower, 1981), it could be concluded, from the Sanchez & Vazquez's results, that attentional biases to positive information would basically depend on mood states that are, by nature, fluctuating. However, our results suggest that current affect is not sufficient to explain attentional deployment towards

positive information. Rather, when a more complex and integrative measure of well-being is included, the relation between experiencing positive emotions and attentional biases towards positive information fully depends upon participants' integrative well-being. This result is congruent with that from other studies. For instance, previous research has shown that current affect may activate attentional biases (Sanchez et al., 2014), but also more stable factors such as dispositional happiness (Raila, Scholl & Gruber, 2015), or optimism (Kress, Bristle & Aue, 2018) may also guide our attentional system. Taking together, our results support the idea that integrative well-being, which includes selected items to assess different aspects of well-being: subjective well-being (i.e., hedonic well-being and life satisfaction), eudaimonic well-being (i.e., life meaning, self-acceptance, personal growth, relation with others, competence, and autonomy), and social well-being (i.e., being symbolically connected to the society at large), favors positive attentional biases which are likely to be adaptive (Vazquez et al., 2018). Thus, the results highlight the relevance of considering different components of well-being when assessing their connection with cognitive processes.

On the other hand, results also reveal that the influence of negative affect on attentional patterns is only partially mediated by integrative well-being. Thus, it seems that negative emotions have a more direct effect on the attentional system than positive emotions, and that they may reduce the adaptive positive bias regardless (or, more precisely, partially regardless) participants' integrative well-being. Yet, interestingly, integrative well-being still mediates the impact of negative mood in attentional processes. These results could be interpreted as evidence that despite the fact that negative emotions may have a strong and direct effect on the cognitive system due to their service to human survival role (Frijda, 2006), variables related to integrative well-being still contribute to

guiding the attentional system by buffering the effects of those negative emotions (Fredrickson, 2001, 2004). Given that attentional deployment towards positive emotion contributes to recover from negative mood (Sanchez et al., 2013), it could be argued that integrative well-being, by altering the impact of negative affect on positive attentional biases, might consequently be playing a role in attenuating the duration or the magnitude of negative emotions themselves. Experimental research should investigate this plausible possibility.

The present results might also have some implications in relation to experimental paradigms aimed to modify dysfunctional attentional biases. It is well known that attentional avoidance of positive information is a crucial mechanism on the onset and maintenance of emotional disorders such as depression (Armstrong & Olantunji, 2012; Duque & Vazquez, 2015). An increased interest in the development of psychological treatments and experimental paradigms capable of modifying the underlying mechanism of psychological disorders has emerged in the last years (see Wykes et al., 2015; Vazquez et al., 2017). The present results suggest that an approach to optimize the modification of attentional biases might be directly reducing negative affect or by increasing integrative well-being components, rather than by boosting positive affect. Additionally, our results might also have some implications regarding the prevention of emotional disorders. Experimental research has posited out that attentional biases towards emotional information might play a crucial role in the onset of emotional disorders (Gotlib & Joormann, 2010). Our mediational model suggests that a global state of well-being has a direct impact on attentional deployment to positive information mediating also the relation between positive affect and attention. Therefore, the implementation of positive psychology interventions aimed at increasing aspects of well-being (e.g., optimism, meaning of life, positive social

relations, etc.) might have a greater impact on selective attention biases than simply focusing on improving momentary positive affect. In turn, these biases might feed virtuous mood-regulation cycles as they may contribute to adaptive mood regulation when confronting with difficulties (Sanchez et al., 2014)

Finally, the present study has some strengths and limitations. Firstly, to the best of our knowledge, this is the first study that simultaneously assesses the influence of different components of hedonic and eudaimonic well-being on attentional patterns to emotional information. Previous research has only addressed the effects of isolated components of well-being (i.e. current emotional state, life satisfaction, or dispositional happiness) on attention (Tamir & Robinson, 2007; Raila, School & Gruber, 2015; Sanchez & Vazquez, 2014). Second, we presented simultaneously positive and negative stimuli competing for participants' attention which is nearer to the processing of stimuli in more real and complex contexts. Further, low-levels features of the stimuli (e.g., luminance and visibility of teeth) was controlled, which reduces the likelihood of confounding factors in the study (Blanco, Serrano-Pedraza & Vazquez, 2017; Calvo & Nummenma, 2011). Also, the use of eye-tracking methodology provides an objective measure of attention which increases the robustness of the results (Armstrong & Olantunji, 2012). However, and regarding to the limitations of our study, the measure used to assess integrative well-being (i.e., the Pemberton Happiness Index), comprises different components of well-being such as life satisfaction and several components of eudemonic well-being which correspond to the Ryff's model of 'psychological well-being' (Ryff, 1989). Future research should address the influence of each isolated component in attention towards emotional information. Additionally, regarding to the measures used in our study, we only introduced variables directly related to well-being. However, previous research has found that attentional biases

can be influenced by a wide range of psychological variables that like optimism (Kress and Aue, 2018), depression (Duque and Vazquez, 2015), pain states (Todd et al., 2018), or anxiety (Okon-Singer, 2018) that can be indirectly linked to well-being. Also, many circumstances may affect to the deployment of attention towards emotional stimuli. For instance, in a recent study, Blanco et al. (2019) used a similar paradigm to the one used in the present study, finding that a 1-month mindfulness retreat affected attentional biases towards emotional stimuli. Therefore, there is abundant evidence showing that other constructs such as, for instance, psychopathology, personality, mindfulness-related variables, emotion regulation processes, etc., are likely to participate in attentional biases.

Further, we only used in our eye-tracking task positive and negative emotional information (i.e. happy and sad faces). Although these emotional categories are closely related to information processing biases in well-being and depression (Armstrong & Olantünji, 2012; Raila, School & Gruber, 2015; Duque & Vazquez, 2015; Grafton & MacLeod, 2017), attentional biases could also appear when other type of emotional contents (e.g. anger, despondency, or pain) are being processed. Again, further studies might analyze the relations between well-being and attentional processing towards these emotional categories.

In conclusion, this study is a further step in the endeavor of understanding the relation between well-being and cognitive processing and the results shed some light about these complex interactions. However, more research is needed to disentangle that complexity, and to understand how this experimental research can help us to develop and design treatments and cognitive training strategies capable to improve well-being.

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Compliance with ethical standards

This project has been approved by the School of Psychology Ethics Committee of Complutense University on December 2, 2014 (the Ethical Committee does not assign reference numbers).

All participants provided informed consent before starting the study. To ensure anonymity, we replaced the names of participants with code numbers to process and analyze the data.

Finally, the authors declare that they have no conflict of interest.

Table1

Table 1. Bivariate correlations between attentional maintenance biases, current affect (positive and negative) and integrative well-being.

	Attentional maintenance bias (Happy vs. Neutral)	Attentional maintenance bias (Sad vs. Neutral)	Attentional maintenance bias (Happy vs. Sad)	Positive Affect (PANAS-PA)	Negative Affect (PANAS-NA)	Integrative well-being (PHI)
Attentional maintenance bias (Happy vs. Neutral)	-					
Attentional maintenance bias (Sad vs. Neutral)	-.240*	-				
Attentional maintenance bias (Happy vs. Sad)	.869**	-.408**	-			
Positive Affect (PANAS-PA)	.325**	-.054	.241*	-		
Negative Affect (PANAS-NA)	-.261**	.067	-.272**	-.123	-	
Integrative well-being (PHI)	.365***	-.229*	.318**	.508**	-.234*	-

Note. *$p < .05$; **$p < .01$

PANAS-PA = Positive and Negative Affect Schedule (Positive Affect scale); PANAS-NA = Positive and Negative Affect Schedule (Negative Affect scale); PHI = Pemberton Happiness Index.

Table 2. Bootstrap mediational analysis (predictor variable: Affect; criterion variable: Positive maintenance bias; moderator variable: Integrative well-being)

			95% CI mean indirect effect	
Path/Effect	*B* mean indirect effect	SE of mean	Lower	Upper
Mediational model: PA --> IWB --> Positive bias HS				
a (PA --> IWB)	1.1317	0.1845	0.7659	1.4976*
b (IWB --> Positive Bias HS)	0.0089	0.0036	0.0018	0.0161*
c (PA --> Positive Bias HS)	0.0183	0.0071	0.0042	0.0324*
c'	0.0081	0.0080	-0.0078	0.0241
a x *b*	0.0101	0.0039	0.0029	0.0186*
Mediational model: NA --> IWB --> Positive bias HS				
a (NA --> IWB)	-0.9381	0.3742	-1.6799	-0.1963*
b (IWB --> Positive Bias HS)	0.0092	0.0031	0.0029	0.0154*
c (NA --> Positive Bias HS)	-0.0371	0.0126	-0.0622	-0.0121*
c'	-0.0285	0.0125	-0.0534	-0.0036*
a x *b*	-0.0086	0.0042	-0.0192	-0.0020*

Note. PA = Positive affect; IWB = Integrative well-being; HS = Happy vs. sad; NA = Negative affect.
*Zero is not in the 95% confidence interval (indirect effect significantly different from zero at $p < .05$)

Table 3. Bootstrap mediational analysis (Predictor variable: Integrative well-being; Criterion variable: Positive maintenance bias; Moderator variable: Affect)

			95% CI mean indirect effect	
Path/Effect	*B* mean indirect effect	SE of mean	Lower	Upper
Mediational model: IWB --> PA --> Positive bias HS				
a (IWB --> PA)	0.2281	0.0372	0.1543	0.3019*
b (PA --> Positive Bias HS)	0.0081	0.008	-0.0078	0.0241
c (IWB --> Positive Bias HS)	0.0108	0.0031	0.0047	0.0170*
c'	0.0089	0.0036	0.0018	0.0161*
a x *b*	0.0018	0.0018	-0.0010	0.0063
Mediational model: IWB --> NA --> Positive bias HS				
a (IWB --> NA)	-0.0586	0.0233	-0.1049	-0.0123*
b (NA --> Positive Bias HS)	-0.0285	0.0125	-0.0534	-0.0036*
c (IWB --> Positive Bias HS)	0.0108	0.0031	0.0047	0.0170*
c'	0.0092	0.0031	0.0029	0.0154*
a x *b*	0.0017	0.0015	-0.0001	0.0058

Note. PA = Positive affect; IWB = Integrative well-being; HS = Happy vs. sad; NA = Negative affect.
*Zero is not in the 95% confidence interval (indirect effect significantly different from zero at $p < .05$)

Supplementary material

Mediational models for Happy vs. Neutral trials.

a) Current Affect → IWB → Positive attention bias

Our results showed that PA significantly predicted IWB (path a; IC = .76590764; 1.49768517) and maintenance bias to happy faces (path c; IC = .001139379; .03971724). Further, when IWB was entered on the model as a mediator, it also significantly predicted maintenance bias to happy faces (path b; IC = .00227329; .01665802) but PA did not (path c'; IC = -.00117724; .03086189). This revealed a true indirect effect of IWB (a x b; IC = .0039001; .01973296). Therefore, since zero was not in the 95% confidence interval, and PA did no longer predicts maintenance to happy faces when IWB was introduced as a mediator, our results revealed that IWB totally mediates the relation between PA and maintenance bias to happy faces. Furthermore, the same total mediation indirect effect emerged when negative affect was introduced as a covariate.

Regarding negative affect as the predictor variable, our results showed that negative affect also significantly predicted both IWB (path a; IC = -.167999671; -.19633264) and maintenance bias to happy faces (path c; IC = -.06272318; -.01077500). Further, when IWB was introduced as a mediator on the model, both negative affect (path c'; IC = -.051553318; -.00072408) and IWB (path b; IC = .00497073; .01767020) significantly predicted maintenance bias to happy faces. Additionally, a significant indirect effect of IWB emerged (a x b; IC = -.02176914; -.00350375). This revealed that IWB partially mediate the relation between negative affect and maintenance bias to happy faces. Finally, the same partial mediation effect emerged when PA was introduced as a covariate.

b) IWB → Current Affect → Positive attention bias

In the second set of mediational models we tested the alternative models (i.e. affect as a potential mediator between IWB and maintenance bias to happy faces).

We tested the mediation role of PA between IWB and maintenance bias to happy faces (on happy vs. neutral trials). Our results showed that PA did not predict the maintenance bias to happy faces (path b; IC = -.00117724; .03086189). Only IWB predicted significantly both PA (path a; IC = .15438970; .3018995) and maintenance bias to happy faces (path c, IC = .00659024; .01911345) Thus, no indirect effect emerged with PA as a mediator. Regarding NA as a potential mediator, our results showed that both negative affect (path b; IC = -.05153318; -.00072408) and IWB (path c; IC: .00497073; .01767020) significantly predicted maintenance to happy faces. However, no indirect effect emerged (a x b; IC = -.00008031; .00523906) since zero criterion lied on the interval confidence. Therefore, neither positive nor negative affect played a role of mediation between IWB and a positive maintenance bias to happy faces (on happy vs. neutral trials).