Dear Dr. Lebon,

We would like to thank you and the reviewers for the provision of valuable comments that contributed to improve the quality of our preprint titled “Automatic approach-avoidance tendency toward physical activity, sedentary, and neutral stimuli as a function of age, explicit affective attitude, and intention to be active”.

Please find below our point-by-point responses to the comments made by the Editor, Reviewer #1 and Reviewer #2. These comments are in bold font, our responses are in regular font, quotes from the manuscript are in italic font, and each change made in the manuscript is in blue font.

Best regards,
Matthieu Boisgontier

EDITOR

As suggested by both reviewers, I would recommend to revise the introduction section, by taking into account the previous literature that also makes sense to you and to deal with the affective and motivational perceptions relative to the practice of physical activity.

Response: As recommended, the introduction has been revised to include the suggested literature.

In order to gain in visibility (especially for readers who are not in the approach-avoidance field), could you clarify specific points in the method and statistical sections? Especially, how was measured the reaction time and what were the instructions for the participants?

Response: As recommended, some methodological descriptions have been clarified.

Regarding the age factor, did the authors split the group in 3 or in 2 (below and above 45 years old)?

Response: Age categories were only reported to describe the dataset. In the statistical models, age was included as a continuous variable. This information was initially missing and has been clarified in the revised version of the manuscript.

As a suggestion (I leave it to the authors to decide whether it is relevant and feasible), I would propose to adopt another structure of the paper. Instead of having the classical structure (Intro, Material & Method, Results and Discussion), the authors could adopt the following structure: Intro, Result/Discussion (which quickly present the method), and Material & Method (in details). So that the readers focus on the main results and their interpretation, then go to the Method section whether they want to fully understand the statistical analysis.

Response: We would respectfully prefer to keep the Methods section right after the Introduction section. In our opinion, putting the methods at the end of the manuscript implicitly lessens its importance. Yet, we believe that the method is at least as important as the results (Boisgontier, 2022).

Reference
- Boisgontier MP. Research integrity requires to be aware of good and questionable research practices. European Rehabilitation Journal. 2022;2(1):1-3. https://doi.org/10.52057/erj.v2i1.24

REVIEWER 1

Please report statistics to help the reader understand the meaningfulness of the differences. There is much to digest in your abstract. The sentences with the 'but' are confusing as we are on track but then we are not. Hence, statistics I believe will be of assistance to abstract readers.

Response: As recommended, statistics are now reported in the abstract and the "but" have been removed.

> Page 1: "*The main results accounted for age, sex, gender, level of physical activity, body mass index, and chronic health condition. They confirmed a main tendency to approach physical activity stimuli (i.e., faster reaction to approach vs. avoid; p = .001) and to avoid sedentary stimuli (i.e., faster reaction to avoid vs. approach; p < .001). Results based on neutral stimuli revealed a generic approach tendency in early adulthood (i.e., faster approach before age 53 and fewer errors before age 36) and a generic avoidance tendency in older adults (i.e., more errors after age 60). When accounting for these generic tendencies, results showed a greater tendency (i.e., fewer errors) to avoid than approach sedentary stimuli in adults aged 51 or older. Exploratory analyses showed that, irrespective of age, participants were faster at approaching physical activity (p = .028) and avoiding sedentary stimuli (p = .041) when they considered physical activity as pleasant and enjoyable (explicit attitude). However, results showed no evidence of an association between approach-avoidance tendencies and the intention to be physically active. Taken together, these results suggest that both age and explicit attitudes can affect the general tendency to approach physical activity stimuli and to avoid sedentary stimuli*."

I am in psychology. Hence, I wonder if you need to mention implicit self-theories (e.g., Dweck's work) and approach-avoidance (for instance Elliot (1999) is a great review. Then you have Elliot and Thrash's work with approach-avoidance constructs. It seems implicit self-theories and approach-avoidance personalities or dispositions influence automatic approach-avoidance tendencies. Elliot works seems appropriate somewhere in your manuscript. The Lochbaum et al. (2020) meta-analysis links approach-avoidance goals to objective and subjective physical activity measures.
- Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. Educational Psychologist, 34(3), 169–189. https://doi.org/10.1207/s15326985ep3403_3
- Elliot, A. J., & Thrash, T. M. (2002). Approach-avoidance motivation in personality: Approach and avoidance temperaments and goals. Journal of Personality and Social Psychology, 82(5), 804–818. https://doi.org/10.1037/0022-3514.82.5.804
- Lochbaum, M.; Zanatta, T.; Kazak, Z. The 2 × 2 Achievement Goals in Sport and Physical Activity Contexts: A Meta-Analytic Test of Context, Gender, Culture, and Socioeconomic Status Differences and Analysis of Motivations, Regulations, Affect, Effort, and Physical Activity Correlates. Eur. J. Investig. Health Psychol. Educ. 2020, 10, 173-205. https://doi.org/10.3390/ejihpe10010015
The Zenko & Ekkekakis and then David Conroy's work makes sense to me as included. Again, there is more out there. I do understand you are assessing automatic approach-Avoidance tendency.

Response: Thank you for the suggested literature. The reviewer is right, approach and avoidance tendencies can be studied using questionnaires at the personality (e.g., approach-avoidance temperaments) or goal level (approach vs avoidance goals) (Elliott et al., 1999; Elliott et al., 2002). Regarding personality, temperament factors such as behavioral activation and behavioral inhibition are notably responsible for behavioral tendencies. These factors refer to the reinforcement-sensitivity theory, which proposes that behavior is triggered by two underlying motivational systems. The behavioral activation system (BAS), associated with approach tendencies, and the behavioral inhibition system (BIS), associated with avoidance tendencies, that is thought to inhibit behaviors associated with reward loss or punishment (Gray, 1987).

However, anchored within a dual-processes approach (e.g., Strack et Deutsch, 2004), we respectfully think that these questionnaire-based approaches are rather distant from the purpose of our study, which is interested in the automatic aspect of approach-avoidance tendencies toward a specific behavior. This automatic aspect is difficult to access through questionnaires and should rather be captured using reaction-time tasks. Yet, as suggested, the work by Elliot and collaborators has been added to the manuscript as follows:

> Pages 2-3: "*Conceptual congruence can also be revealed by manipulating the physical (e.g., pulling or pushing a joystick) or virtual direction (e.g., pressing keyboard keys moving an avatar on a screen; selecting the word "approach") of the response used to react to the stimulus of interest (Krieglmeyer & Deutsch, 2010; Rougier et al., 2018). While generic approach-avoidance tendencies have been studied using questionnaires at the personality (e.g., approach-avoidance temperaments) (Elliott et al., 2002) and goal level (approach-avoidance goals) (Carver & White, 1994; Elliott, 1999), the reaction-time difference in these approach-avoidance tasks captures a more automatic aspect of approach-avoidance tendencies, a specific dimension of automatic attitude (Sheeran et al., 2013).*"

Here (Limitations section), you can mention the psychology works and the measures. You could suggest the measures in future work of this nature.

Response: As suggested, additional limitations have been added as follows:

> Page 14: "*Moreover, the current study did not assess the potential influence of socioeconomic (e.g., income, education; see Pechey et al., 2015 in the food domain), the quality of the motivation towards physical activity (i.e., autonomous vs. controlled) (Berry et al., 2016), personality, and goal-related variables (Elliot, 1999; Elliot et al., 2002) on automatic approach-avoidance tendencies. Testing these associations in future work would clarify the mechanisms underlying the effect of age on approach-avoidance tendencies (e.g., moderating effect of income on the association between age and approach-avoidance tendencies). Regarding motivation quality, beyond developing the intention to be physically active, it seems important to disentangle the reasons beyond this intention (e.g., from more intrinsic to more extrinsic reasons) and to examine how individuals' reasons for action may correlate with more automatic constructs.*"

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REVIEWER #2

In the "Automatic Approach-Avoidance Tendency" during the Introduction section, the pioneer works of Lang that dealt with Approach-Avoidance Tendency depending on emotional, attentional, and motivational contexts appears to be missing to me. This perceptual context would appear to me all the more important as it could may be useful during the discussion / limit section (see later, the last suggestion of the review).

Response: Lang (1995) suggests that approach tendencies are associated with positive emotions and direct the organism toward positive stimuli, while avoidance tendencies are associated with negative emotions and energize avoidance behavior away from negative stimuli. However, Lang (1995) also contends that approach/avoidance tendencies are not rigidly associated with behavior. This association depends on the perception of the context: An approach tendency can lead to an approach behavior but also to freezing (e.g., freezing of a predator approaching a prey) or avoidance (e.g., taking a step back to contemplate a painting). As suggested, the work by Lang has been included as follows:

> Page 3: *"Since then, this effect suggesting an automatic tendency to approach positively-valued concepts and avoid negatively-valued concepts has been replicated numerous times with various types of approach-avoidance tasks and across numerous contexts (Chen & Bargh, 1999; Wentura et al., 2000; De Houwer et al., 2001; Duckworth et al., 2002; Vaes et al., 2003; Rotteveel & Phaf, 2004; Markman & Brendl, 2005; Alexopoulos & Ric, 2007; Rinck & Becker, 2007; Paladino & Castelli, 2008; Seibt et al., 2008; Saraiva et al., 2013; Rougier et al., 2018). As approach-avoidance tendencies play a key role in adapting a broad range of behaviors to the perception of one's context (Lang, 1995), this construct has attracted considerable attention in physical activity.*"
>
> Page 14: *"Considering the intertwining of emotions, approach-avoidance tendencies, and behavior (Lang, 1995), future studies should go beyond the measure of motivational direction (approach vs. avoid) generated by the stimuli. Coupling the approach-avoidance task with self-reported (e.g., self-assessment manikin) (Bradley and Lang, 1994) and other behavioral measures (e.g., eye-tracking) to investigate other indicators (i.e., stimulus-generated arousal and valence) could allow for a better understanding of the automatic reactions associated with physical activity and sedentary stimuli and how they relate to behavioral regulation in a specific context (Moors et al., 2013)."*

The authors took into account the "Explicit Attitudes and Intentions", but what about affective and motivational perceptions linked to the practice of a physical activity? It is a part of human behaviors related to physical activity practices that seemed to me a little bit neglected, at least in the introduction and discussion or limits sections.

Response: Affects related to physical activity were tested using the implicit and explicit attitudes measured in the current study. Implicit attitudes are thought to rely on affective associations with a specific behavior and were measured with the approach-avoidance reaction-time task. Measuring explicit attitudes requires a self-reported measure of the affective attitudes toward physical activity, which was done with the bipolar semantic differential adjectives on a 7-point scale (unpleasant-pleasant; unenjoyable-enjoyable). The statement begins with "For me, to participate in regular physical activity is …". Motivations to practice physical activity were tested using the measure of intention to be physically active. However, we agree that some limitations and potential avenues for future research should be mentioned:

Page 14: *"Considering the intertwining of emotions, approach-avoidance tendencies, and behavior (Lang, 1995), future studies should go beyond the measure of motivational direction (approach vs. avoid) generated by the stimuli. Coupling the approach-avoidance task with self-reported (e.g., self-assessment manikin) (Bradley and Lang, 1994) and other behavioral measures (e.g., eye-tracking) to investigate other indicators (i.e., stimulus-generated arousal and valence) could allow for a better understanding of the automatic reactions associated with physical activity and sedentary stimuli and how they relate to behavioral regulation in a specific context (Moors et al., 2013)."*

Page 14: "*Moreover, the current study did not assess the potential influence of socioeconomic (e.g., income, education; see Pechey et al., 2015 in the food domain), the quality of the motivation towards physical activity (i.e., autonomous vs. controlled) (Berry et al., 2016), personality, and goal-related variables (Elliot, 1999; Elliot et al., 2002) on automatic approach-avoidance tendencies. Testing these associations in future work would clarify the mechanisms underlying the effect of age on approach-avoidance tendencies (e.g., moderating effect of income on the association between age and approach-avoidance tendencies). Regarding motivation quality, beyond developing the intention to be physically active, it seems important to disentangle the reasons beyond this intention (e.g., from more intrinsic to more extrinsic reasons) and to examine how individuals' reasons for action may correlate with more automatic constructs.*"

My strongest request for precision comes now and concerns the method section. Even by re-reading several times and with several round trips through the paragraphs and the sections, it is still difficult for me to really reproduce with no doubt the motor task required by the participant in order to respond to the stimuli and achieve the motor behavior of approach or avoidance.

Response: Thank you for this comment. We have done our best to clarify the specific points mentioned below.

"The participant sitting in front of the computer is instructed to use the "U" key to move the avatar up or the "N" key to move the avatar down" but what is the initial position, and in particular the initial position of the hand(s) required in the initial posture? (During the fixation cross and avatar period?)

Response: Thank you for requesting this clarification. In the initial position, the index fingers are positioned on the "U" and "N" key, without pressing them. This information has been added as follows:

Page 5: "*The participant sitting in front of the computer with one index finger positioned on the "U" and the other index finger on the "N" key […].*"

Was it clear to the participant to use only one hand? Was the pointing finger placed above the "J" key or "H" key in the initial position? or elsewhere? Is the hand movement (in the physical world) always congruent with the avatar movement (in the virtual world)? (or should the hand approach the screen to press the n key, and therefore approach the pictogram, to trigger an avoidance behavior of the avatar?)

Response: Participants used both hands: They were instructed to use both their index fingers. At baseline, one index finger was positioned on the "U" key and the other one was positioned on the "N" key.

Participants were instructed to press the “U” key to move the avatar up or the “N” key to move the avatar down. Accordingly, the movement of the avatar is always congruent with the pressed key: The top key (i.e., U) moves the avatar up, while the bottom key (i.e., N), moves the avatar down. Importantly, however, the approach or avoidance action depends on the initial position of the avatar at the beginning of the trial. If the avatar appears below the stimulus, the top key is associated with an approach movement, while the bottom key is associated with an avoidance movement. Conversely, if the avatar appears above the stimulus, the approach and avoidance movement are reversed – the top key is associated with an avoidance movement and the bottom key is associated with an approach movement. This design provides the manikin task an advantage over the joystick tasks, as explained in the seminal work by Krieglmeyer and Deutsch: “Contrary to the joystick tasks, in the manikin task (De Houwer et al., 2001) recategorisation is rather unlikely. Although in principle, the movements can be recategorised as moving downwards and upwards, this would make the task more difficult instead of easier. The reason for this is that the manikin either appears above or below the stimulus, and, therefore, up and down responses are unrelated to the instructed approach-avoidance responses. Thus, depending on the position of the maninkin, participants have to determine in each trial which response means approach or avoidance. Consequently, the representation of approach and avoidance is activated in each trial.”

> Pages 5-6: “*The participant sitting in front of the computer with one index finger positioned on the “U” and the other index finger on the “N” key is instructed that pressing the “U” key moves the avatar up and pressing the “N” key moves the avatar down. Accordingly, the movement of the avatar is always congruent with the pressed key: The top key (i.e., U) moves the avatar up, while the bottom key (i.e., N), moves the avatar down. Importantly, however, the approach or avoidance action depends on the initial position of the avatar at the beginning of the trial. If the avatar appears below the stimulus, the top key is associated with an approach movement, while the bottom key is associated with an avoidance movement. Conversely, if the avatar appears above the stimulus, the approach and avoidance movement are reversed – the top key is associated with an avoidance movement and the bottom key is associated with an approach movement. This design provides the manikin task an advantage over the joystick tasks, as explained in the seminal work by Krieglmeyer and Deutsch: “Contrary to the joystick tasks, in the manikin task (De Houwer et al., 2001) recategorisation is rather unlikely. Although in principle, the movements can be recategorised as moving downwards and upwards, this would make the task more difficult instead of easier. The reason for this is that the manikin either appears above or below the stimulus, and, therefore, up and down responses are unrelated to the instructed approach-avoidance responses. Thus, depending on the position of the manikin, participants have to determine in each trial which response means approach or avoidance. Consequently, the representation of approach and avoidance is activated in each trial.”*

What exactly does "reaction time" represent in this study? How exactly is this duration determined in this study: between which starting event (I supposed the visual stimulus appearance) and which ending event (Is this the moment when the participant releases a button that was pressed in the starting position? or when the candidate presses the U or N key?). In some Motor Control studies, the reaction time is the duration between a sensorial stimulus and the beginning of the movement that allows the answer task. In such a case, reaction time is different from the Movement Time and the answer time is the addition of the reaction time plus the movement time. However, in other psychology studies, reaction time is a parameter that includes the duration of the answer planification and the duration of the answer execution, even if it is a motor answer. In this case, “Reaction Time” encompasses the movement time. Ultimately, I think that more precision on this parameter will be very useful for the readers.

Response: In our study, the reaction time was the time between the appearance of the visual stimuli and key press.

> Page 6: "*When the reaction time (i.e., the time between the appearance of the stimuli and the key press) was longer than seven seconds, […]*"

Finally, about the physical motor response itself, it seems to be no SOA between the start of avatar appearance and the visual stimulus input (always 1000 ms duration): how to be sure that anticipatory motor response strategies do not emerge in connection with this rhythm, and which could interact with the measured avoidance approach behaviors?

Response: As the reviewer correctly noted, stimulus-onset asynchrony (SOA) was applied between the appearance of the cross and the appearance of the stimulus but not between the appearance of the stimulus and the appearance of the manikin. We agree that participants could have anticipated the response because they internalized the timing of stimulus appearance. But if that was the case, the percentage of error would have been much higher than observed in our study. Moreover, should an anticipatory motor response strategy have emerged, it unlikely emerged in one specific condition only. Because we used a within-subject design, the effect of such a strategy would have cancelled out when computing the reaction-time differences, leaving the reported results unchanged.

Three age classes are carried out. Younger [21-39] years old, Middle age [40-59] and older adults [60-77]. With regard to this classification, how and why is there a threshold of difference in behavior at 45, i.e. within a age class? ("Our results show faster reaction times and fewer errors when approaching compared to avoiding physical activity stimuli before 45 years of age. ") This raises the question of the method of segmentation of age classes a priori and why not again a posteriori when reading the results?

Response: Thank you for this comment. Age categories were only reported to describe the dataset. In the statistical models, age was included as a continuous variable. This variable was not converted into categorical variables to avoid loss of power and residual confounding (Royston et al., 2006). This point has now been clarified in the manuscript.

> Page 7: *"To investigate the effect of age on approach-avoidance bias toward the different stimuli, the first three models tested the interaction effect between age (continuous) and action direction (approach vs. avoid) […]"*

In the previous version of the manuscript, the difference or absence of difference across age were based on the overlap of the 95% confidence area of the regression line of a condition with the regression line of the other condition. We considered that an overlap suggested similar reaction times, while no overlap suggested significant reaction time differences. However, after a closer read of the article by Cumming and Finch (2008), titled "Inference by eye: confidence intervals and how to read pictures of data", we realized that in the case of paired data, it is not possible to formulate a rule of eye based on overlap of separate confidence intervals. Therefore, we have now adopted another approach: We have tested each model with different age centrations to determine the age range during which the effect was significant.

> Pages 7-8: *"The models were tested with different age centrations to determine the age range during which the effects of interest were significant."*

Pages 10-11: *"Participants were significantly faster at approaching than avoiding physical activity stimuli until 64 years of age. […] Participants made fewer errors when approaching than avoiding physical activity stimuli until 41 years of age. […] Participants were significantly faster at avoiding than approaching sedentary stimuli from age 40 onwards. […] Participants were significantly faster at approaching than avoiding neutral stimuli until 52 years of age. […] Participants made fewer errors when approaching than avoiding neutral stimuli until 35 years of age. From age 36 to 57, reaction times to approach and avoid neutral activity stimuli were not statistically different. From age 58 onward, participants made statistically more errors when approaching than avoiding neutral stimuli. […] After 50 years of age, participants made significantly fewer errors when avoiding than approaching sedentary stimuli."*

Finally, the authors report an absence of evidence that could plead in favor of an association between automatic attitudes and intentions to be physically active. The intention to be physically active refers to the levers (and brakes) of the physical practice, as well as to the motivations to practice which can vary, in particular with age. In the category of the youngest adults, physical practice could be the result of intrinsic motivation and sources of own pleasure (positive affect, arousal, with high intensity). Conversely, in older adults, motivation could have an extrinsic tendency to respond to recommendations and societal values which could be external of the individual.

Response: Since age was included in the model testing the association between automatic attitudes and the intention to be physically active, the absence of evidence of this association was estimated to be true irrespective of age. To further address the Reviewer's comment, the interaction effect between direction, intention, and age was tested but results showed no evidence of such effect (p*s*= .75 and .54 for physical activity and sedentary stimuli, respectively). We did not find literature suggesting that motivation could have an extrinsic tendency to respond to recommendations and societal values in older adults.

As such, it could have been useful to collect the subjective evaluation of the affective context that the pictograms engendered in each participant for example by means of a Self-Assessment Manikin. Thus, the subjective measures of affect, arousal and intensity could have been added as regressors to the different models. In this case, perhaps that this perspective could be discussed, mentioned in limit, or why not appear in perspective of further study?

The stimuli used in the current study we selected based on a previous study (Cheval et al., 2018), thirty-two participants were asked to rate the extent to which 24 stimuli expressed "movement and an active lifestyle" and "rest and sedentary lifestyle" (1 = not at all, 7 = a lot). For each stimulus, the "rest and sedentary lifestyle" score was subtracted from the "movement and active lifestyle" score. The six stimuli with the largest positive and negative differences were chosen as the stimuli depicting physical activity and sedentary behaviors in the main experiment, respectively. This information has been added in a new "Physical Activity and Sedentary Stimuli" subsection. In addition, the lack of this type of evaluation in the sample of the current study is now mentioned as a limitation of the study.

Page 6: *"Physical Activity and Sedentary Stimuli.*
In a previous study (Cheval et al., 2018), thirty-two participants were asked to rate the extent to which 24 stimuli expressed "movement and an active lifestyle" and "rest and sedentary lifestyle" (1 = not at all, 7 = a lot). For each stimulus, the "rest and sedentary lifestyle" score was subtracted from the "movement and active lifestyle" score. In the current study, the six stimuli with the largest positive and negative differences were chosen as the stimuli depicting physical activity and sedentary behaviors, respectively."

Page 14: *"Considering the intertwining of emotions, approach-avoidance tendencies, and behavior (Lang, 1995), future studies should go beyond the measure of motivational direction (approach vs. avoid) generated by the stimuli. Coupling the approach-avoidance task with self-reported (e.g., self-assessment manikin) (Bradley and Lang, 1994) and other behavioral measures (e.g., eye-tracking) to investigate other indicators (i.e., stimulus-generated arousal and valence) could allow for a better understanding of the automatic reactions associated with physical activity and sedentary stimuli and how they relate to behavioral regulation in a specific context (Moors et al., 2013)."*

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