Bachelor Thesis

What is the Daily Relationship Between Engaging in Physical Activity and Positive and Negative Momentary Affect?

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Abstract

The relationship between physical activity and positive and negative momentary affect over time has occasionally been researched in the past. However, many of the prior studies used samples of either children and adolescents or targeted their research towards working adults. Thus, the present study focused on a target group of university students. It was assumed that higher levels of physical activity increased positive and decreased negative momentary affect. In order to measure this hypothesis, an ESM study over the course of a week was carried out. 19 participants were recruited via convenience sampling (N=19, M*age* = 22.8 years, 63.2% female, 36.8% male). Participants were subjected to questionnaires on seven consecutive days, three times daily via the Ethica app. The questionnaires assessed the momentary effect and physical activities. The data analysis was conducted using a Linear Mixed Model. In line with the expectations a positive significance in the relationship between positive affect and physical activity as well as negative effect regarding negative affect and activity. These findings suggest that higher levels of physical activity led to more positive and less negative momentary affect. The individual comparison showed that the individual that engaged in more physical activity showed higher levels of positive affect than the participant who rarely was active. Therefore, these findings highlight the importance of physical activity for positive momentary affect. Future research should consider a bigger sample size and a different measurement of physical activity.

Keywords: physical activity, momentary affect, Experience Sampling Methods, university students

What is the Daily Relationship Between Engaging in Physical Activity and Positive and Negative Momentary Affect?

After an exhausting workout, many people tend to feel better mentally (Mental Health Foundation, n.d.). However, the World Health Organization (WHO, n.d.) reported that globally 25% of adults and 81% of adolescents do not engage in sufficient physical activity. People who show little physical activity and sedentary behaviour are more likely to be affected by diseases such as strokes, hypertension, diabetes and obesity (Centers for Disease Control and Prevention, 2022). Physical activity is crucial to maintain a healthy body weight and reducing the risk of attaining diseases, as well as strengthening the bones and muscle structure. A lack of physical activity does not only create major physical but also mental health issues, as it can add to experiencing anxiety and depression (John Hopkins Medicine, n.d.). Additionally, a lack of exercise holds several consequences for mental well-being such as poor body image, emotional distress, and poor quality of sleep (Fox, 1999). Thus, physical activity is of crucial importance for a healthy lifestyle.

Physical activity can be defined as “any bodily movement produced by skeletal muscles that result in energy expenditure.” (Caspersen et al., 1985, p.126). Thus, activities such as sports, walking, and doing chores can be considered physical activities. Adults aged 18 to 64 are recommended to engage in moderate- to vigorous-intensity activities for at least 75 to 150 minutes distributed over the course of one week (WHO, 2022). In addition, people in this age range are advised to engage in muscle-strengthening exercises two times a week for further health benefits.

The benefits of physical activity can be experienced on several levels. Next to improvements in well-being, such as increased self-esteem and better quality of sleep, physical activity has particularly positive effects on mental health (Kim et al., 2020; Pacheco & Wright, 2022). During the past few decades, multiple studies have shown that physical exercise such as aerobic and resistance exercises have a positive influence on mental well-being and decrease mental illness (Bize et al., 2007). For instance, multiple studies and

meta-analyses demonstrated that physical activity reduces symptoms of depression and anxiety (Sharma et al., 2006; Rebar et al, 2015). An experiment by Blumenthal et al. (2000) highlighted that in long-term physical exercise is equally effective in reducing depressive symptoms as anti-depressants and lowers the likelihood of relapsing into depressive episodes. Additionally, Schwerdtfeger et al. (2010) emphasised that physical activity has a positive effect on mental well-being including positive momentary affect. Especially participating in aerobic exercises can aid to decrease negative momentary affect, while engaging in moderate levels of physical activity has been shown to heighten positive affect as well as energetic arousal (Schwerdtfeger et al., 2010; White et al., 2017).

Affect can be defined as a special kind of influence of something or someone on an individual's mind linked to their body (Feldmann Barrett & Bliss-Moreau, 2010). The momentary affective state of a person is closely related to the mental well-being of an individual since momentary affect influences the state of well-being an individual perceives in a current situation (Kahneman et al., 2004; Steptoe & Wardle, 2011). As it is a dynamic construct, affect varies over time and influences the motivation and performance of individuals and refers to the feeling they experience at a certain time point (Gee et al., 2012 & Barrett et al., 2007). Possible underlying mechanisms can be explained by the circumplex model of affect (Matthews et al., 1990; Yik et al., 1999) which uses two major dimensions to explain the affective state. The first main dimension is *valence* and includes the experience of a state of pleasure, ranging from unpleasant to pleasant. The other main dimension is *arousal* which refers to a perceived state of energy and activation which ranges from deactivated to activated. Additionally, a subordinate dimension represents a combination of the first two dimensions and refers to (un-)pleasant - (de-)activation. For instance, joy can be conceptualised as an emotion associated with positive valence and pleasure and it activates the neural system that is associated with arousal (Posner et al., 2008).

In order to assess the relationship between physical activity and momentary affective state over time, the utilisation of the Experience Sampling Method (ESM) can aid to make

sophisticated inferences. An ESM study encompasses a structured diary technique to purposefully evaluate the experiences of individuals in a target group in daily life (Verhagen et al., 2016). Studies that utilising ESM are mainly used in psychological studies and psychiatric patients over the course of a few days to several weeks. Participants give self-reports at multiple time points each day in order to assess their emotions, symptoms or environment (Menchaca, 2020; Verhagen et al., 2016). However, there are only a few ESM studies that investigate the relationship between physical activity and momentary affect. For example, a study by Kanning and Schoebi (2016) assessed the affective states and physical activity of a target group of 65 undergraduate students utilising ESM for 24 hours measuring both variables every 45 minutes. The results stated that energetic arousal was a meaningful predictor for physical activity, while a significant effect of valence might be indicative of a positive affect. In a different ESM study, Wichers et al. (2012) studied female twin pairs who were instructed to report their affective changes before and after being physically active in their daily life. The results showed a significant increase in positive momentary affect for up to two and a half hours after engaging in increased physical activity. There was no effect of physical activity on negative momentary affect.

However, most recently conducted studies concentrated on the influence that momentary affect has on the engagement individuals show in physical activity (Bourke et al., 2021; Hollands et al., 2020). The study of Bourke et al. (2021) used an experimental research design to investigate the association between physical activity and momentary affect in children and adolescents. Furthermore, Hollands et al. (2020) used an EMA design in working adults with depression and found that physical activity is significantly associated with subsequent mood. In contrast, the current study will use an ESM research design over the course of seven consecutive days with a target group of university students regardless of their study level in order to examine the effect physical activity has on momentary affect.

Based on the prior findings and the previously mentioned importance of physical activity for mental and physical well-being, the current study aims to investigate the daily

relationship between momentary affect and physical activity in a target group of predominantly students. It can be hypothesised that engaging in high physical activity leads to more positive momentary affect and less negative momentary affect compared to engaging in low levels of physical activity.

H: Engaging in high physical activity leads to more positive momentary affect and less negative momentary affect compared to engaging in low levels of physical activity.

Methods

Design

This study aims to investigate the long-term relationship between the independent variable momentary affect and the dependent variable physical activity by utilising an ESM study design. Prior to data collection, the University of Twente Ethics Committee approved the present study (no. 230205).

Participants

Via the SONA system of the University of Twente and social media, 24 participants were recruited using volunteer sampling. However, due to a technical error, five students were unable to fill out the informed consent and therefore had to be excluded. From the remaining 19 participants, the majority was female (63.2%), and the most frequent nationality was German (57.9%), followed by Dutch (26.3%) and lastly other nationalities (15.8%). The mean age of the participants was 22.8 (*SD* = 2.4; *Min* = 20; *Max* = 31). Most of the participants were following a bachelor's programme (78.9%) or master's programme (15.8%) and one participant (5.2%) was occupied in another way as this study was conducted.

Procedure

In this study, the questionnaires and instruments were implemented into the online application *Ethica* version 632. The study was distributed via social media stories (*Instagram*, *Facebook* and *WhatsApp*), as well as the SONA credit system which is a test-subject pool of the Faculty of Behavioural, Management and Social Sciences at the University of Twente.

Requirements for participating in this study were to be proficient in the English language and to own a mobile device that is capable of downloading the *Ethica* application. The ESM study was officially published on the 27th of March and the data recruitment was terminated on the 17th of April. Prior to starting the actual ESM study, the participants were asked to fill out a baseline questionnaire including the informed consent form and a short questionnaire about their demographic data such as age, gender and nationality. In the informed consent participants were educated about the purpose of the study as well as their right to withdraw from their participation at any time. Only after complying by answering “Yes, I agree” to the informed consent participants were able to receive further questionnaires. For seven consecutive days, the participants were required to fill out the Positive and Negative Affect Schedule (PANAS) in order to measure the dependent variable momentary affect three times daily. Additionally, they were asked to indicate whether they have engaged in any physical activity. Between 9 a.m. and 11 p.m., the participants received three push notifications from *Ethica* (at 9 a.m., 2 p.m. and 9 p.m.) on their smartphones asking them to fill out a survey which should have taken the participants approximately two minutes. After receiving the notification, the participants had two hours to fill out the questionnaire. They were sent a reminder notification one hour before the questionnaire expired in case, they did not complete it beforehand. On the last day of the study, every participant received an email including the researcher’s contact information and was thanked for their participation. Additionally, the participants who signed up through the SONA system were asked for their SONA ID in order to grant the participants their credit (1). Participants who were not part of the BMS faculty of the University of Twente did not receive any compensation for their participation.

Materials

Momentary Affect

The momentary affect of the participants was measured daily utilising the Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988). The measuring instrument is a

self-reporting questionnaire containing 10 items, developed by Wichers et al. (2011). PANAS is suitable to track momentary changes in positive and negative emotions of individuals as it is sensitive to the perceived affect at the moment respondents are filling out the scale (Magyar-Moe, 2009). This scale is suitable for the current ESM studies as it required less time to be completed than the original scale by Watson et al. (1988). Specifically, the extent to which participants felt “cheerful, content, insecure, lonely, energetic, anxious, low, enthusiastic, guilty, and suspicious” at the given moment were rated on a 7-point Likert scale ranging from 0 (not at all) to 6 (very). Higher sum scores on either of the subscales indicated a higher positive or respectively negative momentary affect. Concerning the psychometric properties, it can be said that both scales have shown to have good internal consistency reliability (Wichers et al., 2011) which was also valid for the present study as the mean Cronbach’s alpha positive momentary affect equalled .91 and .89 for negative momentary affect.

Physical Activity

Additionally, the physical activity of the participants was measured by asking them a dichotomous yes or no question about whether they engaged in physical activity, which was defined as all movements performed for at least 20 minutes consecutively (WHO, 2022). Physical activity, for example, includes sports during leisure time, transport by bike or walking to get from places and physically demanding work of a person. Lastly, the short open question “What type of physical activity did you engage in?” was included to gain more specific insight into the most prevalent types of activities the students participated in.

Data Analyses

After conducting all observations, the sample was analysed by using the data analysis tool R Studio version 1.3.1073. Firstly, the data has been cleaned and prepared for further analysis using Microsoft Excel. In addition to this, the positive and negative momentary affect values were calculated by summing the reported values for each subscale respectively. Afterwards, the demographic data including the age, country of origin, gender,

and current occupation, respectively level of study, were analysed. Then, the response rate was calculated as well as the Cronbach's alpha of the 10-item version of the PANAS for this study.

As a next step, the open question about the type of physical activity the participants engaged in was qualitatively coded by one researcher and the number of times participants engaged in a certain type of activity was calculated. Following this, the participants were grouped into low, medium and high levels of physical activity assuming they engaged in the minimum amount of 20 minutes of activity for each reported observation of physical activity according to the WHO (2022).

Next, a linear mixed model analysis was performed to test the relationship of positive and negative momentary affect against physical activity, while accounting for the multiple observations that have been made per participant over time. Lastly, to achieve more detailed insights, two individuals from the sample group, selected based on their physical activity level, were compared individually by creating a graph for each of them. One participant was chosen to display an overall high level of physical activity of any kind while the other was selected to show a low level of the same. Another selection criterium for the choice was that for both participants a similar number of observations has been made. For each participant, a line graph was plotted to show their positive and negative momentary affect respectively over time.

Results

Of the 19 participants, 217 observations have been analysed which resulted in a response rate of 54.39%. In order to not reduce the current sample size any further with the goal to increase the response rate, no participants were excluded due to their low number of responses.

Physical Activity

The results of the qualitative analysis demonstrated that 65 of the 217 observations (*n* = 19) contained engagement in physical activity for at least 20 minutes. As illustrated in

Table 1, the most prevalent type of physical activity is walking (observations = 35; *n* = 11), mainly to get from one place to another. Following that, going to the gym and weightlifting (observations = 11; *n* = 4) were also common types of activities. The least performed type of exercise was low-impact exercises such as yoga or pilates (observations = 2; *n* = 1).

Table 1

Qualitative coding of the types of physical activity and frequency of engagement.

Type of physical activity	Number of times engaged in physical activity type, *n* (%)
Walking (getting from A to B)	35 (57.9)
Gym and weightlifting	11 (21.1)
Team sports	7 (36.8)
Moderate to high-intensity cardio	6 (15.8)
Chores	4 (21.1)
Low-impact exercises (like Yoga)	2 (5.3)

Note. The number of activities reported by participants throughout participating in the study.

In the sample, only three out of the 19 participants engaged in the minimum amount of physical activity recommended by the WHO (2022), assuming that the individuals only engaged in the minimum of 20 minutes required to be categorised as a session of being physically active. In the frame of this study, they were considered highly physically active. From the remaining participants, 42.11% reported medium physical activity levels with being three to four times physically active for at least 20 minutes over the course of the study. The other 42.11% of participants only engaged in low levels of physical activity with one observation or no observations at all.

Relationship Between Physical Activity and Momentary Affect

Results of the Linear Mixed Model analysis showed that the association between physical activity and positive momentary affect was significant (b_{pos} = 2.72, *SE* = 0.74, $t(204.33) = 3.69$, $p < .001$, 95% CI [1.28, 4.18]). Additionally, the intercept term estimated at 11.42 was also significant (*SE* = 0.92, $p < .001$), which indicated a significant baseline level

of physical activity when momentary affect is zero. The variances varied substantially in positive momentary affect between the grouping variable of the individual participants (Var_{pos} = 14.94, *SD* = 3.87) with a residual variance within participants of 18.08 (*SD* = 4.25). In addition, a negative significant association was found between negative momentary affect and physical activity (b_{neg} = -1.62, *SE* = 0.58, *t*(197.99) = -2.82, *p* < .005, 95% CI [-2.76, -0.49]). The estimated negative affect when physical activity was zero as indicated by the estimated intercept is 7.52 (*SE* = 1.802, *t*(17.92) = 4.17, *p* < .001). In this analysis, the random intercepts for the grouping variable also varied substantially in the negative affect between participants (Var_{pos} = 60.21, *SD* = 7.759). The residual variance among participants was 10.71 (*SD* = 3.303).

These results indicated that participants who were more physically active experienced higher levels of positive affect and lower levels of negative affect, which was in line with the expectations. Consequently, the hypothesis can be accepted.

Positive Momentary Affect Levels over Time in Two Individuals

To zoom in on the relationship between physical activity and momentary affect over time, the observations of two individuals from the sample were plotted in graphs (Figure 1). Momentary affect ranged on a scale from 0 to 25 on the y-axis and the observations for each participant can be seen on the x-axis. Firstly, 15 observations were analysed for participant 70817 (Age = 22) who received the pseudonym “Lucy” in order to keep the participant's real name confidential, and 13 observations for participant 70936 (Age = 23) who was given the pseudonym “Emily” for the same reason. Lucy was chosen because of her low level of physical activity. Both identified as female at the moment the questionnaire was conducted. Over the period of seven days, Lucy reported having been active one time for at least 20 minutes which classified her as being lowly physically active whereas for Emily, eight observations of activity have been made. Therefore, Emily was considered highly physically active.

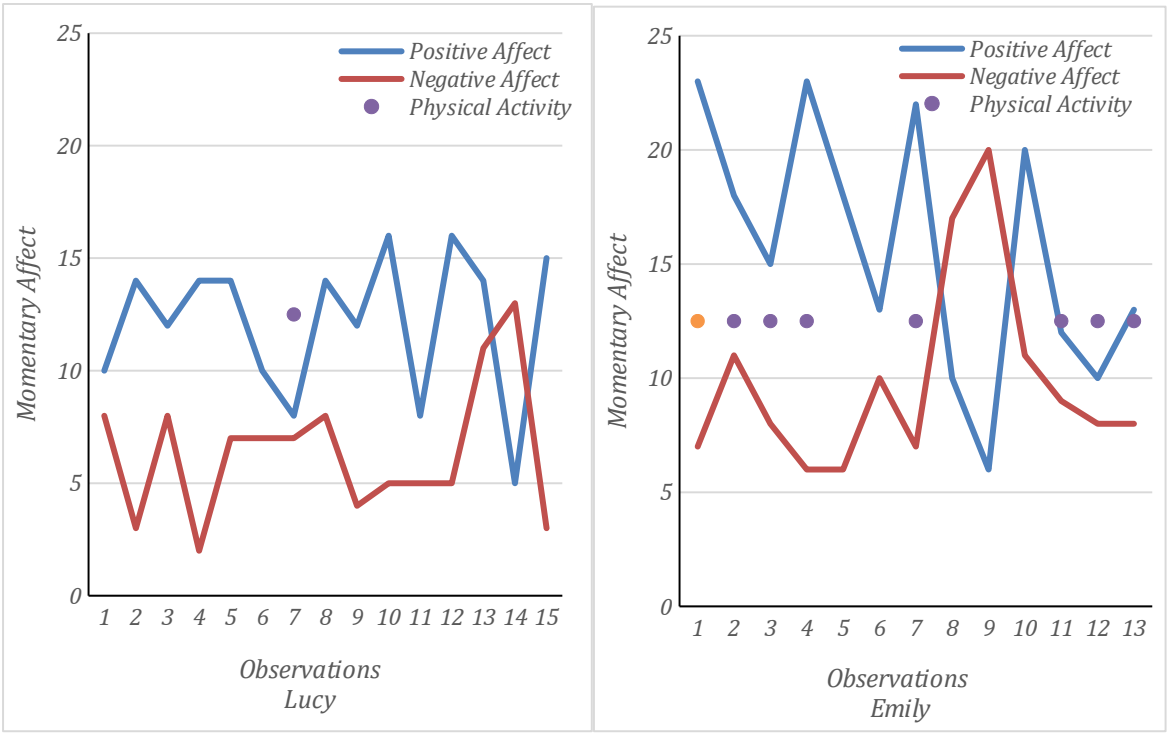
Upon closer examination of the line graph displaying positive momentary affect, Emily (*M* = 15.62, *Min* = 6, *Max* = 23) generally reported higher levels than Lucy (*M* = 12.13, *Min* = 5, *Max* = 16). Comparing the negative momentary affect levels of Lucy (*M* = 6.4, *Min* = 2, *Max* = 13) and Emily (*M* = 9.85, *Min* = 6, *Max* = 20), it can be seen that the lines show more similarities, although the summarising statistics differ. In addition, the mean value for positive affect in Emily was 15.62 (*SD* = 5.5, Var_{pos} = 30.26) and the mean value equalled 12.13 for Lucy (*SD* = 3.27, Var_{pos} = 10.69). The mean value for negative affect in Emily was 9.85 (*SD* = 4.22, Var_{pos} = 17.81) whereas for Lucy it was 6.4 (*SD* = 3.01, Var_{pos} = 9.11).

When looking at the moment of observation for the physical activity of Lucy, it is remarkable that her positive momentary affect decreases (*X* = 7, *Y* = 8) whereas her negative momentary affect remains the same (*X* = 7, *Y* = 7)). In contrast, Emily's positive momentary affect seemed to have been positively influenced by physical activity, as she reported high levels of positive momentary affect after engaging in physical activity, whereas her negative affect remained at low levels when observations of activity have been made.

One abnormality can be seen in the trends of positive and negative momentary affect on each of the line graphs. In the graph displaying the observations of Lucy, a decline of positive momentary affect by 9 at the 14th observation and a surge of negative momentary affect by 8 is visible from the 12th to 14th observation. In comparison, for Emily, a similar abnormality occurred with their negative affect rising by 13 and a drop by 16 in positive momentary affect from the 7th to 9th observation. For both participants, the trend seemed to have returned to normality after these short and strong shifts.

Figure 1

Comparison of momentary affect in low-level physical activity participant Lucy (left) and high-level physical activity participant Emily (right).



Discussion

This ESM study aimed to examine the relationship between daily momentary affect and the level of physical activity. The findings revealed that significance is found in the relationship between momentary affect and physical activity. Specifically, participants who exhibited higher levels of physical activity also showed higher levels of positive and lower levels of negative affect, whereas participants that were less physically active also experienced less positive and higher levels of negative momentary affect. This was also supported in the individual comparison of two participants where one participant was highly active and the other exhibited low levels of physical activity.

Interpretation of the Results

The results from this study revealed that there is a significant relationship between physical activity and positive and negative momentary affect. These findings are consistent with previously performed studies (e.g. Wichers et al., 2012; White et al., 2018) as those

demonstrated a similar relationship to the current study. This suggests that increased physical activity leads to an increase in positive affect and less negative momentary affect in students. Therefore, the results validate the existing theories as this study provides additional evidence for this research field. However, there were considerable variations found in the random effects for positive and negative momentary affect, as those widely spread from each other. This is in line with prior research as a study by Schoevers et al. (2020) showed that momentary affect fluctuates greatly over time, especially in individuals suffering from depression or anxiety. Additionally, momentary affect fluctuates in relation to physical activity depending on what context the activity occurs (White et al, 2017). White et al. (2017) showed in a sample of students, that leisure time activity increased momentary affect more than activity that occurred for instance in order to get to school or other means of transportation. This might also apply to university students and explains variations in positive momentary affect in association with different types of physical activity.

In the comparison of the line graphs, it became visible that whenever the positive affect decreased the negative momentary affect increased. In line with that, the negative affect values dropped when higher positive momentary affect values were observed. Additionally, for the highly active person positive momentary affect increased after physical activity whereas it remained at the baseline level for the lowly active person. This could indicate that physical activity influences momentary affect especially in long-term when an overall high level of activity has been established (Blumenthal et al, 2000). An abnormality in the trend of the graphs was visible for each of the participants. For the highly active participant Emily, a downward trend of positive and an upward trend of negative momentary affect could be observed at the 7^{th} to 9^{th} moment of observation. The same abnormality was also visible for Lucy who displayed overall low levels of physical activity at the 12^{th} to 14^{th} observation. This decrease in positive affect and increase in negative affect deviates from the overall trend observed throughout the data collection period. These fluctuations might have been caused by external factors other than physical activity such as a change in

emotional experience due to an unpleasant or unforeseen event (i.e., receiving a bad grade, an argument with a friend, etc.) or greater rumination levels as compared to the other moments of observation (Hjartarson et al., 2021). Both participants were able to return to a higher level of positive momentary affect that is in line with their general trend after the drop in the graph which might be attributable to the *hedonic treadmill.* This theory claims that people tend to return to their baseline level of contentment after an incident which is also applicable to an individual's baseline level of positive affect (Fontane Pennock & Neuhaus, 2016).

The sample of the current study was mainly composed of individuals (84.2%) that engage in low to medium levels of physical activity which makes it more challenging to make sophisticated inferences about the relationship between momentary affect and physical activity. Additionally, it can be assumed that most of the engagement in physical activity is not deliberate as the qualitative analysis illustrates that the majority of physical activity is performed by means of getting from one place to another. Furthermore, only three participants have engaged in the minimum amount of activity recommended by the WHO (2022). Opposing to expectations, university students do not engage in the required amount of physical activity and if they did, they mostly engaged in low-impact activities. Contradicting the current findings, the results of Kljajevic et al. (2021) suggest that university students engage in a satisfactory level of physical activity and fitness. In addition to that, the current trend in the fitness industry shows that individuals tend to engage in more physical activity as home workouts become more popular, and the number of gym memberships increases (Theunissen, 2023). Thus, it might be necessary to increase awareness and knowledge about the benefits of physical activity and the risks of sedentary behaviour and being overweight. If people get more educated about the beneficial influence that physical activity can have on their mental well-being, including decreasing their depression and anxiety levels, they might be more inclined to engage in adequate levels of activity.

Strengths and Limitations of the Study

The current study has methodological as well as conceptual strengths that can contribute to the research field of health psychology. Through the applied ESM data collection, the participants could report their feelings and behaviours on multiple occasions over a period of seven days while functioning in their natural environment (Verhagen et al., 2016). Additionally, ESM studies have a high ecological validity as they are made during the participants' day-to-day life. Next, the study was designed to cause the participant the least amount of effort to participate as the questionnaires were kept as short as possible. Lastly, the concept of physical activity was defined in accordance with the standards of the WHO (2022) and participants could indicate the type of physical activity in a short open question rather than having to comply with predefined activities.

Despite the strengths this study possesses, some limitations that are worth to be considered. First, the study had a limited sample size of 19 participants. It can be said that a larger sample size would have allowed more sophisticated inferences on the relationship between momentary affect and physical activity. Generally, it is advised to have a sample size of at least 83 participants in an ESM study in order to enable generalisability and enhance confidence in the results (Gabriel et al., 2018; Faber & Fonseca, 2014). In this study, however, only 24 participants could have been recruited, although the study was designed in a way that ensures a minimum of effort required by the participants. Out of this initial sample size, five participants had to be excluded due to a technical error with the application that was used to carry out the observations, which led to some participants not being issued the baseline questionnaire including the informed consent. Using their data despite this issue would be considered unethical (Sil & Das, 2017). Additionally, it is worth mentioning that a larger range of participants might have been necessary for this research. The representation of participants that showed high levels of physical activity was relatively small as compared to the remaining sample. Another limitation is that the response rate was relatively low even though the participants received a notification and an additional reminder

for every questionnaire that was to be filled out. A low response rate may affect the results in terms of limiting the adequate representation of the target group, reducing the statistical power and decreasing the reliability of the results (van Berkel et al., 2017). According to van Berkel et al. (2017), this might be due to study fatigue (participants losing interest after a certain amount of time), lack of motivational elements (i.e. gamification) and expiry time (allowing more time to answer the questionnaire before it expires). Finally, physical activity was only measured by one dichotomous question (yes/no) concerning the participant's engagement in physical activity and one short open question about what type of activity they engaged in. The questions about physical activity only included questions about the minimum amount of 20 minutes to be classified as physical activity according to the WHO. In order to make more sophisticated inferences about the levels of physical activity, another question should have been added in which the participants can indicate the exact length of their activity session.

Practical Implications and Recommendations for Future Research

There are some implications of this study that might be worth considering when conducting research in the future. In case a similar study will be performed in the future, more participants should be recruited in order to ensure the generalisability of the results (van Berkel et al., 2017 & Gabriel et al., 2018). This could be done by reaching out to potential participants using more versatile methods of recruitment. For instance, rather than focusing on Facebook and Instagram stories and a university intern test pool, it is possible to distribute invitations to participate in the study via certain online groups that are interested in the research topic (Ryerson University, 2017). Other possibilities are to print hand-outs including the essential study details and requirements to participate to recruit more physically active participants (UCI Regents, 2022). Alternatively, recruiting students by walking around campus to ask them personally if they would be willing to participate (UCI Regents, 2022). Not only the sample size, but the response rate also needs to be increased in future research which can be done by minimising the study fatigue of participants. Thus, the gamification of

the study can help to increase intrinsic motivation and decrease the study fatigue of respondents (van Berkel & Kostakos, 2021). For instance, the app could be programmed in a way that rewards participants with an achievement notification when filling out a certain number of questionnaires. This endowed progress effect is also used by smartphone applications such as Duolingo or Apple Fitness which provide an artificial advancement towards a certain goal in order to increase a person's motivation (Panagiotidi, 2021). Additionally, extrinsic motivation could be enhanced by not only offering SONA credits as a reward but also a (financial) compensation by means of, for example, a gift voucher (van Berkel et al., 2017). Furthermore, it is crucial to ensure that all surveys and questionnaires are issued correctly to avoid the risk of experiencing technical errors that might lead to the necessity to exclude more participants than necessary. Moreover, it might be helpful to selectively collect more participants that are physically active (notice with QR-code to study in gyms) and let them indicate their perceived level of physical activity in the baseline questionnaire of the study to ensure that enough participants show the desired level of activity to qualify as highly physically active. Lastly, another question should be introduced in the survey to investigate the length and duration participants spent being physically active. In order to measure the intensity of physical activity, there are different and more accurate possibilities of measurement rather than self-report questionnaires. For example, the participants could use a smartwatch to measure their heart rate and the steps they take in a certain time frame (Sylvia et al., 2015). When implementing all of these recommendations it might be possible to achieve improved insights into this research field.

Conclusion

This study offers insight into the relationship between momentary affect and physical activity. While prior research mainly focused on children and adults and often used an alternative research design such as cross-sectional research and EMA, this study used ESM in a sample of predominantly university students. The results revealed that engaging in higher levels of physical activity relates to more positive and less negative momentary affect

which underscores prior findings. Nevertheless, some limitations are worth considering in prospective research such as the low sample size and high attrition which can be improved by motivating the target population to participate in the study. Furthermore, future research should measure physical activity more carefully. This could for example be achieved by asking more detailed questions and using adequate devices to measure activity in order to make more sophisticated inferences in this field of research. Finally, it can be concluded that students should engage in more physical activity as this would improve their positive momentary affect as well as their well-being in the long-term. In order to motivate them to engage in more activity, short questionnaires like the PANAS scale can be included into fitness apps so that participants can also track their momentary affect beneath their physical activity. This would allow them to track their individual changes in how physical activity can benefit their well-being.

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Appendices

Appendix A

Circumplex model of affect