Text Messages Promoting Mental Imagery Increase Self-Reported Physical Activity in Older Adults: A Randomized Controlled Study

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11   ADULT

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1   Abstract

2   This study tested whether text messages prompting older adults to perform mental imagery

3   would increase Aerobic Physical Activity (APA) duration using a randomized parallel trial

4   design.

5   Method: Older adults were assigned to an Imagery 1, Imagery 2 or Placebo group. For 4

6   weeks, each group was exposed to two conditions (morning text message vs. no morning text

7   message). In the morning message condition, the Imagery groups received a text message

8   with the instruction to mentally imagine performing an APA and the Placebo group received a

9   placebo message. All participants received an evening text message: "Did you do your cardio

10   today? If yes, what did you do?" 3 days per week.

11   Results: Participants of the Imagery groups reported significantly more weekly minutes of

12   APA in the morning text message condition compared with the no morning message

13   condition.

14   Conclusion: Electronic messages was effective at increasing minutes of APA in older adults.

15   *Keywords:* cell phone, mental imagery, older adult, physical activity

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1   Text Messages Promoting Mental Imagery Increase Self-Reported Physical Exercise in Older

2   Adults: A Randomized Controlled Study

3   **Increasing Physical Activity for Health in Older Adults**

4   Physical inactivity has been estimated to cause 3.2 million deaths per year (WHO,

5   2013[i]) and was the fourth leading risk factor for global mortality in 2011, accounting for more

6   than 20% of the diabetes, cancer and ischemic heart disease cases (World Health

7   Organization: WHO, 2011[ii]). Conversely, physical activity has a well-documented positive

8   impact on aging (Albinet, Boucard, Bouquet, & Audiffren, 2010; Charansonney, 2011;

9   McPhee et al., 2016; Stacey, Kozma, & Stones, 1985) and by consensus is today considered a

10   medicine (Taylor, 2014). The WHO currently recommends a minimum of 150 minutes of

11   physical activity per week. Nevertheless, despite the wide disparity across studies (Sun,

12   Norman, & While, 2013), it seems that only 17% of the adults between 55 and 64 years old

13   and less than 16% of those who are older are meeting this recommendation (Centers for

14   Disease Control & Prevention, 2013; Myers & Gonda, 1986). The worldwide community of

15   researchers on chronic diseases is consequently struggling to find the best strategies to

16   encourage people to be more active (Denison, Vist, Underland, & Berg, 2014). The strategies

17   of health promotion and physical activity campaigns are a major center of interest (Brawley &

18   Latimer, 2007; Leavy, Bull, Rosenberg, & Bauman, 2011) as it is assumed that these

19   campaigns can have a significant impact on behavior. From this perspective, several

20   innovative strategies have been explored, such as using the internet (Duncan et al., 2014),

21   personalized videos (Vandelanotte et al., 2015), video games (Studenski et al., 2010) and

22   mobile devices (Fong et al., 2016; Johnston, Hoffman, & Thornton, 2014). The latter in fact

23   led to the concept of mobile health (mHealth) (Fiordelli, Diviani, & Schulz, 2013; O'Reilly &

24   Spruijt-Metz, 2013).

25   **Text Messaging as a Way to Increase Physical Activity in Older Adults**

1   Although the use of new technologies generally spreads quickly, fewer than 20% of

2   UK adults older than 65 years and at risk of type 2 diabetes owned a smartphone in 2013[iii],

3   but 77% in the 64-74 age group owned a non-smart mobile phone in 2011[iv]. Texting as a tool

4   for health promotion has therefore become a focus in mHealth research (Hall, Cole-Lewis, &

5   Bernhardt, 2015; Morton et al., 2015) based on the idea that, like marketing strategies, it may

6   be able to prompt people to change their behaviors in a desired way (Cole-Lewis & Kershaw,

7   2010). The effectiveness of texting in promoting physical activity has in fact been

8   documented (for a review, see Fanning, Mullen, & McAuley, 2012) and this strategy was

9   found to generate positive feedback and attitudes (Gerber, Stolley, Thompson, Sharp, &

10   Fitzgibbon, 2009). Given the observations that older adults are increasingly using cell phones

11   (Selwyn, Gorard, Furlong, & Madden, 2003[v]) and that they have easier access to these phones

12   than to other technologies (Gerber, Olazabal, Brown, & Pablos-Mendez, 2010), designing

13   new ways to use them to promote health (Gell, Rosenberg, Demiris, LaCroix, & Patel, 2015)

14   and physical activity (Morton et al., 2015; O'Reilly & Spruijt-Metz, 2013) has become an

15   obvious research objective. Several studies (Antoine Parker & Ellis, 2016; Kim & Glanz,

16   2013; Muller, Khoo, & Morris, 2016) have shown that text messaging increases certain

17   domains of self-reported Aerobic Physical Activity (APA) and one study reported an

18   objective increase in pedometer measurements (Kim & Glanz, 2013).

19   **Mental Imagery as an Innovative Way to Increase Physical Activity in Older Adults**

20   Mental Imagery (MI) refers to the mental simulation or re-creation of a perceptual

21   experience (Kosslyn, Ganis, & Thompson, 2001). MI can be carried out in various ways,

22   including auditory, olfactory, tactile, gustatory, kinesthetic, and visual modes (Cumming &

23   Williams, 2014). In the physical activity sciences, MI has been widely explored as a strategy

24   to enhance sports performance (Di Rienzo et al., 2015; Robin et al., 2007) or as a tool in

25   physical therapy (Slimani, Tod, Chaabene, Miarka, & Chamari, 2016) mainly through its

1   visual and motor aspects. However, occasional practitioners and non-athletes generally report

2   that visual imagery is the easiest to use (Lorant & Nicolas, 2004). A comprehensive yet

3   inexpensive method of determining a person's abilities for visual and kinesthetic imagery is

4   the self-report questionnaire (Hall, 2001). According to Williams et al. (2012), one of the

5   most popular and commonly used questionnaires is the revised Movement Imagery

6   Questionnaire (MIQ-R; Hall & Martin, 1997), which has proven valuable for controlling for

7   individual differences in imagery interventions (Debarnot, Sahraoui, Champely, Collet, &

8   Guillot, 2012; Robin et al., 2007).

9   Many years ago, Paivio (1985) proposed that MI in sports, or "sport imagery," has two

10   main roles that can be broken down into five non-exclusive functions. Mentally rehearsing

11   race plans and strategies of play (CG; cognitive general imagery) or skills (CS; cognitive

12   specific imagery) are proposed to be the two cognitive functions of sport imagery. Imagining

13   the arousal and anxiety associated with performing (MG-A; motivational general–arousal

14   imagery), imagining being in control and feeling confident (MG-M; motivational

15   general–mastery imagery) and imagining goal achievement and accomplishment (MS;

16   motivational specific imagery) are proposed to be the three motivational functions. The Sport

17   Imagery Questionnaire (SIQ) (Hall, Mack, Paivio, & Hausenblas, 1998) was designed to

18   explore these five domains, respectively: SIQ CG, CS, M-GA, M-GM and MS.

19   The motivational functions of mental imagery and their ability to influence behaviors

20   have been documented, especially in the field of eating disorders (Missbach, Florack, &

21   Konig, 2015). In the field of physical activity promotion, very few works are available (Chan

22   & Cameron, 2012; Martin & Hall, 1995). MI was found to increase the intrinsic motivation

23   and quantity of practice of beginner golfers (Martin & Hall, 1995). It was also found to

24   increase approach motivation, intentions post-session and action planning for physical activity

25   in non-active adults (Chan & Cameron, 2012).

1   In the sports domain, mental coaches usually include MI for training and competition

2   programs (Rushall, 1991). As these coaches cannot always be physically present to guide the

3   imagery sessions (e.g., international competitions), they frequently use cell phones and

4   particularly text messages to give the imagery instructions (Target, 2012). We might therefore

5   expect that this kind of procedure would also be beneficial for non-athletes and older adults.

6   Indeed, in the marketing context, MI via text messages is used to prompt purchases and

7   purchase intent in consumers of all ages (Lao, 2011). Based on the assumption that MI can

8   increase the duration of physical practice (Hall et al., 1998), we hypothesized that an MI

9   prompt via cell phone would increase APA duration by strengthening motivation.

10   The aim of this study was to determine whether MI text messages would increase the

11 minutes of APA in older adults. As observed by Martin and Hall (1995) with beginners, we

12 assumed that the effectiveness of the motivation specific (MS) function of imagery, which is a

13 means of modifying cognitions related to goals and motivation, would increase the minutes of

14 APA in the imagery groups. APA prompts sent 3 days per week therefore supplemented a

15 twice-weekly strength training program with a fitness instructor. However, the participants

16 were not currently meeting the WHO recommendation of 150 minutes per week of APA. The

17 aim of this research was to test the efficacy of the imagery intervention for increasing weekly

18 minutes of APA, not necessarily to achieve 150 minutes or more.

19   **Methods**

20 **Trial design**

21   The study was a randomized controlled trial with a parallel design of three arms

22 (Figure 1).

23 **Participants**

24   Eighty-nine volunteers (49 females, 40 males; M_{age} = 62.56 years, age range: 51–73

25 years) were recruited from a certified fitness center for older adults in La Rochelle, France.

1   They all met the following inclusion criteria: (1) 50 years of age or older, (2) member of the

2   fitness center for at least 6 consecutive months, (3) currently participating in group strength

3   training with a professional fitness instructor at least twice a week but not meeting the WHO

4   recommendation for weekly APA, and (4) able to send and receive e-mail and/or text

5   messages from a cell phone over a 4-week period. Two participants (1 female and 1 male)

6   were excluded because they reported having low imagery ability, and 87 volunteers (47

7   females, 40 males; M_{age} = 62.87 years, age range: 51–73 years) thus were retained for the

8   entire experimental procedure (see Table 1 for demographic and clinical characteristics for

9   each group). The experiment was approved by the local ethics committee and was conducted

10   in accordance with the Declaration of Helsinki.

11   _____

12   Table 1 near here

13   _____

14   **Procedure and Intervention**

15   All participants were successively and in random order exposed to two 2-week periods

16   (session 1: weeks 1–2 / session 2: weeks 3–4) from 3 September to 1 October 2016. At the

17   beginning of the study, all the participants met together, and the Principal Investigator (PI, the

18   first author) presented the procedure, explained how to carry out the visual and kinesthetic

19   imagery, and answered questions. The participants then signed an informed consent form,

20   filled out a personal information questionnaire, and completed two questionnaires assessing

21   imagery ability and use. They were then randomly assigned to the Imagery 1, Imagery 2 (with

22   a similar but counterbalanced condition to control for the order effect) or Placebo group by

23   drawing lots made by the PI, as illustrated on Figure 1.

24   _____

25   Figure 1 near here

1   _____

2   The study lasted 4 weeks. The Imagery and Placebo groups received a morning text

3   message (at 7:00 am) 3 days per week for 2 weeks. In the other 2 weeks, they received no

4   morning messages. The morning message for the Imagery groups told them to "Visually

5   imagine yourself performing a cardio activity," whereas for the Placebo group, the message

6   was the exchange rate for the euro from the day before: for example, "1 euro = 1.07 dollars."

7   After receiving the morning text message, the Imagery and Placebo groups simply had to send

8   the message "received" to the PI.

9   All the participants also received an evening text message at 7:30 pm, 3 days a week

10 for 4 weeks, asking "Did you do your cardio today?" Once the evening text messages were

11 received, they completed the APA participation form by cell phone e-mail or text message

12 and sent it to the PI. They had to respect a specified answer format, and when the response

13 was "yes," they were expected to report the type of APA, duration in minutes, and intensity

14 (moderate or vigorous).

15 **Measures**

16   **Electronic Aerobic Physical Activity Participation Form.** The electronic APA

17 participation form, previously used by Antoine Parker and Ellis (2016), asked two questions:

18 "Did you do your cardio today? and "If yes, what did you do?". As noted, when APA was

19 reported, the participants specified the type of activity (e.g., bike, walk, swim, etc.), duration

20 in minutes and intensity (moderate or vigorous). As bias can occur with self-report

21 questionnaires, we used the French version of the Marlowe-Crowne Social Desirability

22 Scale–short form C (MCSD) (Blais, Lachance, & Riddle, 1991; Verardi et al., 2010) and, as

23 recommended by Crowne and Marlowe (1960), divided the participants into three groups: low

24 scorers (0–3, $n = 13$), average scorers (4–7, $n = 57$) and high scorers (8–13, $n = 17$).

1   **Imagery Ability.** We assessed individual imagery ability to ensure that the sample did

2   not include anyone with extremely high or low mental imagery ability (see Robin et al., 2007;

3   for a similar procedure) and especially ensured that none of the participants encountered

4   difficulties in realizing visual imagery. Before the beginning of the experiment, all the

5   participants completed the Movement Imagery Questionnaire–Revised (MIQ-R) (Hall &

6   Martin, 1997). The MIQ-R measures movement imagery ability for basic and daily life

7   movements. The MIQ-R is an 8-item self-report questionnaire in which participants rate the

8   ease or difficulty of forming a mental representation using two 7-point Likert-type scales (1 =

9   *very hard to see/feel* and 7 = *very easy to see/feel)* referring to visual and kinesthetic imagery,

10   respectively. Psychometric properties of the MIQ-R have been consistently adequate, with a

11   Cronbach (1951) α of .82 for both visual and kinesthetic scales (Lorant & Nicolas, 2004).

12   **Imagery Use.** We used the Sport Imagery Questionnaire (SIQ; Hall et al., 1998),

13   which is designed to assess the use of the five cognitive and motivational functions of

14   imagery. The SIQ is composed of 30 questions, six questions per imagery function. Each item

15   is rated on 7-point Likert-type scale (1 = *rarely use that function of imagery* and 7 = *often use*

16   *that function of imagery*). An average frequency score for the participants' use of each of the

17   five functions was then calculated. Internal consistency values range from $\alpha = .70$ to $\alpha = .88$,

18   are satisfactory for the five SIQ subscales, and the scale possesses good validity (Hall et al.,

19   1998). The sample was divided into three groups based on the SIQ MS scores (high, medium

20   and low MS groups) to specifically evaluate the influence of the motivational specific

21   function of imagery.

22   **Preliminary Data Analysis**

23   We first examined the MIQ-R scores and each of the five SIQ scores across the

24   experimental conditions to confirm that there was no difference between groups. Data were

1   checked for MIQ-R and each of the SIQ scores outliers considering values more than 2 SD

2   above or under the mean.

3   Second, to evaluate the eventual influence of social desirability, two one-way

4   ANOVAs were performed. The first compared the low, average and high scorer groups with

5   regard to the increase in minutes of APA. The second compared the MCDS scores between

6   each group (Imagery 1 vs. Imagery 2 vs. Placebo).

7   **Preliminary Results**

8   **Imagery Use and Ability.** The MIQ-R visual and SIQ scores (mean, standard

9   deviation and range) are presented in Table 2. Two of the participants had MIQ-R visual

10   scores lower than 16 (corresponding to "hard to see/feel" for all the items of the

11   questionnaire) and their data were excluded from the statistical analyses. The ANOVAs

12   revealed no main group effect on the MIQ-R visual scores, $F(2, 84) = 0.11$, $p > .05$, or the

13   five functions of the SIQ scores (CS, CG, MS, M-GM, M-GA), $F(2, 84) = 0.03$, $p > .05$, $F(2,$

14   $84) = 0.85$, $F(2, 84) = 0.58$, $F(2, 84) = 0.02$, $F(2, 84) = 1.01$, respectively ($ps > .05$).

15   _____

16   Table 2 near here

17   _____

18   **Social Desirability.** The ANOVAs revealed no main effect of the MCSD group on

19   minutes of APA, $F(2,84) = 0.62$, $p = 0.53$ (Table 3), and comparable social desirability in the

20   experimental groups, $F(2,84) = 0.05$, $p = 0.95$ (Table 4).

21   _____

22   Tables 3 and 4 near here

23   _____

24   **Data Analysis**

1   To determine whether the two Imagery groups could be combined, the order effect

2   (Imagery 1: "Imagery morning message condition followed by no morning message

3   condition" versus Imagery 2: "no morning message condition followed by Imagery morning

4   message condition") on APA was then explored by a two-way ANOVA with a group factor

5   and a session factor, APA being the dependent variable.

6   We then performed a two-way ANOVA to explore the effect of condition and session

7   on the minutes of APA on the whole sample. To evaluate the influence of the MS function of

8   imagery on the increase in minutes of APA (mean differences between morning message and

9   no morning message conditions on minutes of APA) for the Imagery group participants, a

10   one-way ANOVA compared the low, medium and high MS groups.

11   For all analyses, the significant main effects and interactions were broken down using

12   the HSD Tukey test for the one-way ANOVA and the Newman-Keuls test for the ANOVA

13   with session. Normality was checked (Kolmogorov-Smirnov test), effect sizes (η_p^2) were

14   indicated, and α was set at .05 for all the analyses.

15   **Results**

16   **Aerobic Physical Activity**

17   The weekly minutes of APA according to experimental condition are presented as

18   means and standard deviations (see Table 5). The first two-way ANOVA revealed that there

19   was no order effect on minutes of APA in either of the two Imagery groups, $F(1, 56) = 0.01$, p

20    $< .01$. We therefore combined the two groups into one.

21   We then performed another ANOVA to explore the effect of group (Imagery vs.

22   Placebo) on minutes of APA with the type of morning message (imagery message vs. placebo

23   message) as a between-subject factor and a repetition factor (morning message vs. no morning

24   message) as a within-subject factor.

1   The ANOVA revealed a significant main effect of group, $F(1,85) = 9.61$, $p = .002$, η_p^2

2   $= 0.10$, and a significant main effect of type of morning message, $F(1,85) = 28.85$, $p = .000$,

3   $\eta_p^2 = 0.25$. Moreover, the ANOVA revealed a significant interaction between group and type

4   of morning message, $F(1,85) = 26.01$, $p = .000$, $\eta_p^2 = 0.24$. The post-hoc Newman-Keuls test

5   revealed that the participants of the Imagery group reported significantly more average

6   weekly minutes of APA ($M = 99.53$) in the morning imagery message condition compared

7   with the no morning message condition ($M = 72.73$). Moreover, as illustrated in Figure 2, the

8   participants of the Placebo group showed no significant difference between the morning

9   placebo message condition ($M = 72.10$) and the no morning message condition ($M = 71.41$).

10   None of the participants reported vigorous APA in their electronic responses.

11   _____

12   Table 5 and Figure 2 near here

13   _____

14   **Influences of SIQ MS Scores on APA**

15   Since "4" was the most frequently reported SIQ MS score and represented more than

16   half the sample, we divided the sample into three groups: the low MS group with scores lower

17   than 4 ($n = 15$), the medium MS group with scores equal to 4 ($n = 32$), and the high MS group

18   with scores higher than 4 ($n = 11$). The ANOVA revealed a main effect of group, $F(2,55) =$

19   3.65, $\eta_p^2 = 0.06$, on the increase in minutes of APA. The post-hoc HSD Tukey test revealed

20   that participants in the high and medium SIQ MS groups had greater increases in minutes of

21   APA than participants in the low SIQ MS group (Figure 3).

22   _____

23   Figure 3 near here

24   _____

1   **Discussion**

2   **Limitations**

3   The duration of the morning text message condition (2 weeks) could be considered

4   short, despite its positive results. However, the study objective was to determine whether text

5   messages to prompt mental imagery would increase minutes of APA in older adults, and we

6   compared our findings with those of other studies using similar protocols to facilitate the

7   interpretation of the results (i.e., Antoine Parker et al., 2016; Prestwich, Perugini, & Hurling,

8   2010). Our study should thus be viewed in the context of previous research with similar

9   characteristics that also demonstrated the effectiveness of prompts for changing behavior

10   (Antoine Parker et al. 2016; Fry & Neff, 2009). The results are promising, suggesting the

11   positive effects of cell phone imagery prompts to promote short-term APA. Further research

12   is needed to evaluate whether this strategy is effective for long-term APA participation. The

13   self-reporting of APA minutes might be another limitation, although this was modulated by

14   the absence of any group difference according to social desirability. We may assume that a

15   few participants over- or underestimated their minutes of APA, and this may have been the

16   case with the evaluation of the intensity of APA, as well (none of the participants reported

17   vigorous activity). Further research is needed using objective measurements of APA, such as

18   heart rate monitoring, pedometers or doubly-labeled water.

19   **Generalizability**

20   The aim of this study was to determine whether cell phone prompts with imagery

21   scripts would increase APA participation in adults aged 50 years and older. The results

22   showed that, in the Imagery groups, the average weekly minutes of APA were significantly

23   higher in the morning text message condition, during which participants had to visually

24   imagine themselves doing an APA, than in the no morning message condition. The results of

25   this original study are consistent with previous research showing that cell phone prompts

1   related to physical activity increased the physical activity of younger adults (Fanning et al.,

2   2012; Fry & Neff, 2009) and older adults (Antoine Parker & Ellis, 2016; Kim & Glanz, 2013).

3   Indeed, the latter authors showed a significantly greater weekly duration of APA in a group

4   that received the electronic reminder in the morning than during the control condition when

5   the morning reminder was not delivered. Moreover, our use of a Placebo group showed that a

6   placebo morning message, which had no relation to physical activity but merely indicated the

7   euro versus dollar exchange rate, had no influence on APA. This non-significant result is

8   important because it suggests that the Imagery group participants benefited from the message

9   content and not from the message itself. An MI message is therefore useful to improve APA

10 duration in older adults and may also be beneficial for younger participants or pregnant

11 women, for example. MI prompts can complete or replace other prompts that suggest or insist

12 on APA. The act of imagining oneself engaged in physical activity could be considered a self-

13 motivational technique and probably activates a specific neural network that incites this

14 behavior.

15 **Interpretation**

16   The results of the current study extend the literature by providing evidence that

17 imagery text delivered via cell phones can also be a successful strategy for increasing weekly

18 minutes of APA among older adults. Indeed, the increase of APA was about 36.8% (with a

19 quite small sample size $\eta_p^2 = 0.24$) with morning imagery text. It seems that imagery text

20 prompts are as effective as other prompts like "Don't forget to do cardio today" used in

21 Antoine Parker et al. (2016) study, for example, in which the increase was 35.2% (with a

22 small sample size $\eta_p^2 = 0.18$). Moreover, it seems important to note that in the morning text

23 condition, participants of the Imagery groups averaged about 33 minutes of APA each

24 message day versus 24 minutes of APA on the days without the morning text message or 23

25 minutes of APA for the Placebo group participants who received a placebo morning message.

1   We can assume that if the MI messages had been delivered 4 to 5 days per week, the

2   participants would have been on track to meet the WHO physical activity recommendation

3   (150 weekly minutes of APA).

4   As hypothesized, the results suggest that imagery text messages are an effective

5   intervention strategy for increasing APA in adults 50 years and older who regularly engage in

6   physical activities. As Paivio (1985) observed, MI is frequently used to enhance sports

7   performance. It has nevertheless been reported that the beneficial effects of MI on sports

8   performance are modulated by numerous factors (Hall, 2001). For example, Short, Tenute,

9   and Feltz (2005) suggested that individual differences in imagery ability influence the

10   frequency of imagery use and how effective the imagery will be. Furthermore, the differences

11   in imagery ability may be one reason why people choose not to use imagery even when it

12   could be beneficial. In order to control for the influence of this factor, all the participants

13   completed the MIQ-R and none of them were categorized as poor or good imagers (Robin et

14   al., 2007). Another factor that can influence the beneficial effects of MI is the fitness level of

15   the participants. Most of the sports imagery research has been conducted with adult athletes

16   (Hall et al., 2009). According to Martin and Hall (1995), these athletes use imagery to modify

17   cognitions and regulate arousal and anxiety, which are classed as serving motivational

18   general-arousal and motivational general-mastery functions. When these athletes need to learn

19   or improve movement performance, they use the cognitive specific function of imagery, and

20   for strategies, game planes and routines, they use the cognitive general function. Moreover,

21   Hall and collaborators (1998) suggested that athletes use all five functions of imagery to a

22   greater extent than amateur or recreational athletes. Nordin and Cumming (2007), on the other

23   hand, revealed that athletes show the lowest frequency scores for MS imagery, and athletes

24   and non-athletes differ in their imagery use. Indeed, in the early stages of skill acquisition,

25   novices attend to cognitive cues regarding the skill being learned and use imagery primarily

1   for its cognitive function to assist in organizing information (about the skill or strategy) at the

2   central processing level (Murphy & Jowdy, 1992). However, it should be noted that the older

3   adults in this study were not learning a new task or movement, which probably explains their

4   higher scores on the MS imagery function than the other four functions. Indeed, the other

5   functions are more oriented toward competition or learning, whereas MS imagery entails

6   imagining goal achievement and accomplishment. Moreover, our results are consistent with

7   those of Martin and Hall (1995) with beginner golfers, as these authors demonstrated that MS

8   imagery is effective for modifying cognitions related to goals and motivation. In their study,

9   the participants with six imagery sessions spent more time practicing a golf-putting task and

10   adhered more closely to their training program than the participants in the no-imagery control

11   group. A complementary analysis revealed that the participants who reported medium and

12   high SIQ MS scores had greater increases in APA duration than those with low SIQ MS

13   scores. These results confirm the literature and are consistent with the idea that MS imagery

14   enhances motivation (Martin et al., 1999) to practice a physical activity.

15   Few studies have examined electronic prompts on cell phones to increase APA

16   participation in older adults (Antoine Parker et al., 2016; Tabak, Op den Akker, & Hermens,

17   2014) and none has tested mental imagery text messages. The results of our study confirm

18   previous research results indicating that electronic prompts can increase APA in older adults

19   and show the benefits of mental imagery messages. As suggested by Paivio (1985), mental

20   imagery has a motivational role that can improve physical practice. The use of mental

21   imagery text messages may be an easy-to-use, cost-effective and beneficial method to

22   increase APA in older adults.

23   **Note**

1 [i] World Health Organization Diet and Physical Activity Factsheet. Secondary Diet and

2 Physical Activity Factsheet 2013.

3 http://www.who.int/dietphysicalactivity/factsheet_inactivity/en/index.html

4 [ii] World Health Organization. Global status report on noncommunicable diseases 2010.

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Table 1

Participants demographic and clinical characteristics

Variables	Imagery 1 Group ($n = 30$)	Imagery 2 Group ($n = 28$)	Placebo Group ($n = 29$)
Demographics			
Sex	57% females	54% females	52% females
Age (years)	61.59 (7.35)	62.54 (6.54)	64.48 (5.23)
Marital Status	47% Married	43% Married	52% Married
Race/ethnicity	100% White	97% White	100% White
Education	50% College	46% College	52% College
Medium financial income	97%	100%	100%
History of disease			
Bone	13%	7%	3%
Cancer	10%	14%	17%
Cardiovascular	13%	10%	3%
Thyroid	7%	11%	3%
Spine	3%	0%	7%
Other	17%	14%	21%
No disease reported	40%	46%	38%

Table 2

Descriptive statistics for imagery use and imagery ability.

Measure	*M*	*SD*	Range
SIQ			
Cognitive Specific	1.62	0.57	1-3
Cognitive General	1.28	0.50	1-3
Motivational Specific	3.93	0.74	2-5
Motivational General-Arousal	1.85	0.63	1-4
Motivational General-Mastery	1.75	0.64	1-3
MIQ-R			
Visual	23.83	1.87	19-28
Kinaesthetic	21.35	1.84	18-28

Table 3

Mean scores and increase of Aerobic Physical Activity (APA) of the groups (Low scorers, Average scorers, and High scorers) according to the French version of the Marlowe-Crowne measure of Social Desirability scale (MCSD).

Groups	*M1* MCSD scores	*SD*	Range	*M2* increase of APA	*SD*
Low scorers (n = 13)	2,46	0,49	1-3	23,38	14,89
Average scorers (n = 57)	5,5	0,93	4-7	26,95	18,74
High scorers (n = 17)	9,17	1,07	8-11	21,97	15,46

Note: M1 = Mean MCSD scores, M2 = Mean increase of minutes of Aerobic Physical Activity (mean differences between morning text and no morning text conditions minutes of APA).

Table 4

Mean Marlowe-Crowne measure of Social Desirability (MCSD) scale scores of the groups (Imagery 1, Imagery 2, and Placebo).

Groups	*M* (*SD*)	Range
Imagery 1 (n = 30)	5.63 (2.25)	2-11
Imagery 2 (n = 28)	5.82 (2.35)	2-10
Placebo (n = 29)	5.69 (2.32)	1-11

Table 5

Weekly minutes of aerobic physical activity, by conditions, for the Imagery and Placebo Groups

Groups Conditions	Week 1 *M* (*SD*)		Week 2 *M* (*SD*)		Week 3 *M* (*SD*)		Week 4 *M* (*SD*)	
Imagery 1 (*n* = 30)								
Imagery morning text	*98.44*	*(29.31)*	*99.82*	*(28.01)*	xxxx	xxxx	xxxx	xxxx
No morning text	xxxx	xxxx	xxxx	xxxx	*72.55*	*(33.17)*	*73.03*	*(29.84)*
Imagery 2 (*n* = 28)								
Imagery morning text	xxxx	xxxx	xxxx	xxxx	97.96	(26.60)	101.51	(26.73)
No morning text	*73.27*	*(32.30)*	*72.03*	*(35.75)*	xxxx	xxxx	xxxx	xxxx
Placebo (*n* = 29)								
Placebo morning text	*72.75*	*(29.20)*	*71.44*	*(32.80)*	xxxx	xxxx	xxxx	xxxx
No morning text	xxxx	xxxx	xxxx	xxxx	*72.03*	*(26.97)*	*70.79*	*(30.50)*

Note: M = Mean weekly minutes of aerobic physical activity, (SD) = standard deviation

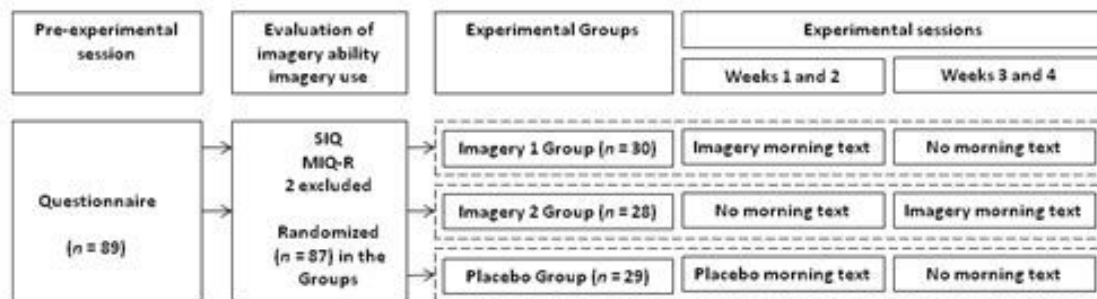Note: M = Mean MCSD scores, (SD) = standard deviation

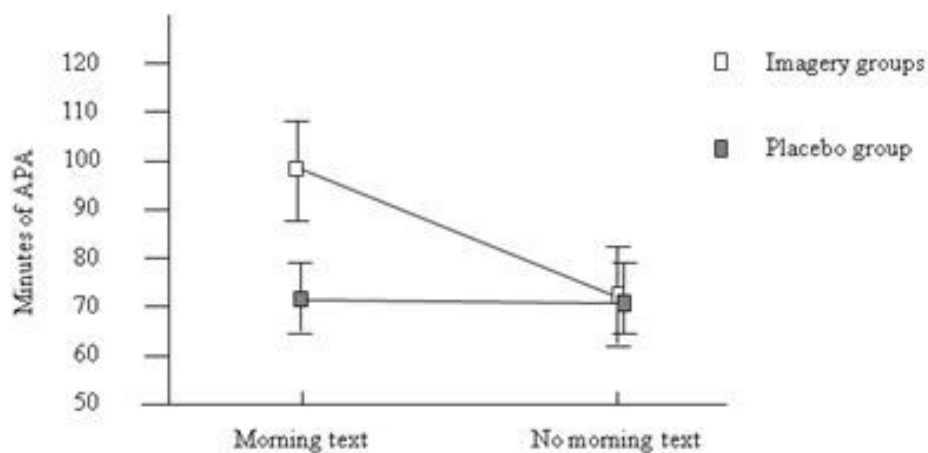*Figure 1.* Time course of the experimental design

Figure 2. Significant interaction between condition (Morning text vs. No morning text) and groups (Imagery vs. Placebo) by ANOVA. I-beams indicates the 95% confidence intervals for the mean values.
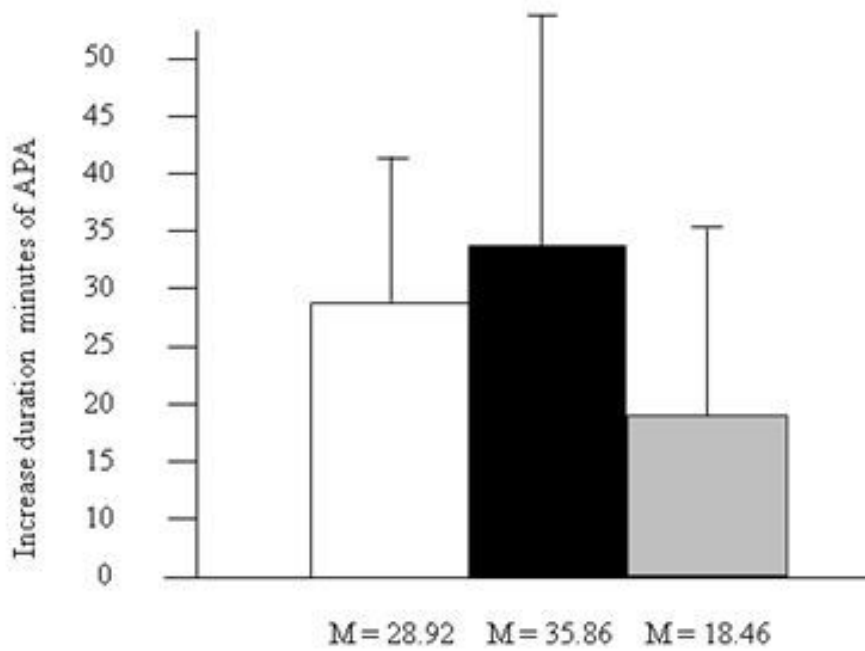
Figure 3. Main effect of the High (white bars), Medium (black bars) and Low (grey bars) SIQ-MS groups on the increase of the duration of aerobic physical activity (APA). I-beams indicates the 95% confidence intervals for the mean values.