Motivational interviewing in a web-based physical activity intervention: questions and reflections

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SUMMARY

The purpose of this study was to identify which question/reflection format leads to the most favorable results in terms of effect on autonomous motivation and appreciation for the intervention in a web-based computer-tailored physical activity (PA) intervention, based on principles from self-determination theory (SDT) and motivational interviewing (MI). For this purpose, a randomized trial was conducted among 465 Dutch adults, comparing three web-based computer-tailored MI/SDT PA interventions, including (i) exclusively open-ended questions (without skillful reflections), (ii) exclusively multiple choice questions (with skillful reflections) and (iii) including both question types (with skillful reflections). Measurements included motivation-related determinants of PA and process variables, measured at baseline, directly following the intervention and 1-month post-intervention. Results suggest that open-ended questions represent an important element in web-based MI in terms of effect on autonomous motivation. In order to optimize appreciation of the intervention, a combination of both open-ended and multiple choice question types seems to hold most promise. The findings of this study suggest that both open-ended and multiple choice questions should be included in web-based computer-tailored SDT/MI PA interventions. More research is needed to reveal the optimal configuration of this novel intervention type.

Key words: internet; motivational interviewing

INTRODUCTION

Strong evidence shows that regular physical activity (PA) decreases the risk of many adverse health conditions such as coronary heart disease, type 2 diabetes, and breast and colon cancer (Lee et al., 2012). International PA guidelines state that for enhanced health adults should accumulate 30 min or more of moderate intensity PA on at least 5 days per week (Garber et al., 2011). According to this standard, almost half of the Dutch population is insufficiently active (Hildebrandt et al., 2013). Therefore, developing effective interventions to promote PA behavior is of great importance to public health (Glasgow and Emmons, 2007).

Research indicates that PA interventions using computer tailoring (CT) are more successful than interventions in which generic information is provided (Neuhauser and Kreps, 2003; Kroeze et al., 2006). In CT interventions, the content of the provided materials is based on characteristics specific to each individual (Rimer and Kreuter, 2006). In the last decade, more and more CT interventions are web based, instead of print delivered, which allows conceivably for more interactivity, higher accessibility and lower costs (del Hoyo-Barbolla et al., 2006; Lustria et al.,
2009; Peels et al., 2012). The findings of a recent meta-review suggest that internet-delivered PA interventions are useful in producing small but significant increases in PA (Davies et al., 2012).

Currently, the majority of web-based computer-tailored PA interventions have been grounded in theories such as social cognitive theory (SCT), the trans theoretical model (TTM) and the theory of planned behavior (TPB) (Enwald and Huotari, 2010; Laplante and Peng, 2011; Davies et al., 2012). Consequently, existing interventions mostly focus on theoretical constructs such as stages of change, modeling, attitude and self-efficacy. Current research on PA uptake and maintenance, however, increasingly shows the importance of another theoretical construct: autonomous motivation (Sweet et al., 2009; Bagoien et al., 2010; Sebire et al., 2011; Silva et al., 2011). More specifically, increasing evidence shows that greater autonomous motivation predicts higher PA frequency and maintenance (Teixeira et al., 2012). While autonomous motivation does not play an explicit role in SCT, TTM or TPB, it is a key construct in self-determination theory (SDT) and in motivational interviewing (MI) (Ryan and Deci, 2000; Miller and Rollnick, 2013).

Resnicow et al. (Resnicow et al., 2008) showed that tailoring on SDT and MI principles can indeed be successful in print-based CT. To our knowledge, however, little research has been done on integrating SDT and MI in web-based CT. Considering the above, web-based computer-tailored PA interventions would probably benefit from being based on the theoretical construct of autonomous motivation as well as on the theoretical insights from SDT and MI (Ryan et al., 2008; Fortier et al., 2012).

**Self-determination theory**

SDT is a broad-based theory of human motivation (Ryan and Deci, 2000; Deci and Ryan, 2008; Ryan et al., 2008). Central to the theory is the distinction between autonomous and controlled motivation. Autonomous motivation includes both intrinsic motivation (when someone is motivated to perform a certain behavior by enjoyment or satisfaction) and identified regulation (when someone is motivated by the pursuit of personally valued outcomes). Controlled motivation consists of both introjected regulation (when someone is motivated by the avoidance of negative emotions such as guilt) and external regulation (when someone is motivated by the prospect of rewards or the avoidance of punishments). Autonomous and controlled motivation are hypothesized both to strengthen and direct behavior, but to lead to very different outcomes, with autonomous motivation leading to greater commitment and long-term maintenance of behavior (Ryan and Deci, 2000; Markland and Ingledew, 2007; Deci and Ryan, 2008; Ryan et al., 2008). According to SDT, autonomous motivation is more likely to arise in an individual when the social context supports the basic psychological needs for autonomy (the need to engage in behavior with a sense of choice), competence (the need to feel competent and confident) and relatedness (the need to feel connected to and understood by others) (Ryan and Deci, 2000; Deci and Ryan, 2008; Ryan et al., 2008).

**Motivational interviewing**

Motivational interviewing (MI) is defined as ‘a collaborative conversation style for strengthening a person’s own motivation and commitment to change’ (Miller and Rollnick, 2013). The core or ‘spirit’ of MI encompasses principles of partnership, acceptance, compassion and evocation. Along with these principles, four overlapping processes are discerned in MI: engaging, focusing, evoking and planning. In order to carry out these principles and processes, the practice of MI implicates applying four core counseling skills: OARS (asking Open-ended questions, Affirming, Reflecting and Summarizing (Miller and Rollnick, 2013).

According to several scholars, SDT can offer a theoretical framework for deepening our understanding of the efficacy of MI (Markland et al., 2005; Patrick and Williams, 2012; Vansteenkiste et al., 2012). More precisely, it is argued that the specific strategies in MI may fulfill the clients’ basic psychological needs for competence (e.g. by using techniques to explore and build confidence), autonomy (e.g. by allowing clients to discover their own reasons for change) and relatedness (e.g. by being compassionate) (Markland et al., 2005).

**A study towards web-based motivational interviewing**

In the present study, it is proposed that incorporating SDT and MI into web-based computer-tailoring...
can bring about efficient and innovative behavior change programs. Constructing such programs seems feasible since web-based CT allows messages to be tailored to answers automatically, and immediately after they have been given, which enables simulating a dialog between program and user (Bickmore and Giorgino, 2006; del Hoyo-Barbolla et al., 2006). Ideally such interventions should integrate the spirit, processes and skills of MI, and be based on the underlying theoretical framework of SDT. The present study aims to take a first step towards this goal. Since the MI core counseling skills (OARS) are considered to be essential throughout the whole MI process (Miller and Rollnick, 2013) we chose to focus explicitly on integrating two of these skills: asking open-ended questions and (skillfully) reflecting.

According to the principles of SDT and MI, the counselor should stimulate the client to come up with his or her own answers. Indeed, as the process provides clients with room to express themselves, the use of open-ended questions is associated with autonomy support (Ryan et al., 2011). An automated intervention, however, is unable to reflect on open-ended answers. Hence, if an intervention were composed of open-ended questions, the computer-tailored feedback messages could at best comprise generic feedback combined with exact copies of some of the participant’s prior answers. Because such a feedback message adds little or no meaning to what the participant has said, this can be seen as a simple reflection (Moyers et al., 2005; Pierson et al., 2007).

Complex—or skillful—reflections typically add substantial meaning or emphasis to what the client has said. These reflections serve the purpose of conveying a deeper or more complex picture (Moyers et al., 2005; Pierson et al., 2007). In web-based computer-tailored interventions, this type of feedback can be achieved rather well by using multiple choice questions. In this approach, the answers on two (or more) multiple choice questions lead to a specific feedback message, which corresponds with that unique combination of answers. Hence, it is possible to provide very specific feedback messages, through which it seems that the information derived from the specific combination of (prior) multiple choice answers is ‘interpreted’. This approach enables skillful reflections to be provided, which could contribute to greater support for competence and relatedness, as well as to greater appreciation for the intervention. Multiple choice questions, however, clearly offer less space for the participants to come up with their own answers, which may limit the capacity for this format to fully support autonomy (Ryan et al., 2011).

Considering the above, in the context of an SDT/MI web-based computer-tailored PA intervention, it might be most appropriate to combine both open-ended and multiple choice questions. This approach would enable both autonomy support (through the presence of open-ended questions) and skillful reflections (through the presence of multiple choice questions).

The purpose of this study was to identify which question/reflection format leads to the most favorable results in terms of effect on autonomous motivation and appreciation for the intervention in a web-based computer-tailored SDT/MI PA intervention, by (i) using open-ended questions (without skillful reflections), (ii) using multiple choice questions (with skillful reflections) or (iii) using both question types (with skillful reflections). It was expected that the most favorable results in terms of autonomous motivation and appreciation for the intervention would occur when both question types are present (as well as skillful reflections).

**METHODS**

**Study design**

A three-arm randomized trial was conducted in which three web-based computer-tailored SDT/MI PA interventions were compared: (i) including exclusively open-ended questions, without skillful reflections (OE), (ii) including exclusively multiple choice questions, with skillful reflections (MC), (iii) including both multiple choice questions and open-ended questions, with skillful reflections (OE&MC). By comparing these intervention conditions, conclusions can be drawn about the additional value of an open-ended answer format above and beyond skillful reflections (and multiple choice questions), and about the additional value of skillful reflections (and multiple choice questions) above and beyond an open-ended answer format. Measurements were taken using web-based questionnaires before the intervention (baseline), directly after the intervention (follow-up 1) and 1 month post-intervention (follow-up 2).
Participants
The participants were Dutch adults (18–70 years old). Exclusion criteria included impairments that severely impede PA participation (participants were asked whether they were unable to be physically active), not speaking and/or writing Dutch and not having internet access. The participants were recruited in October 2011 through an internet panel of Dutch inhabitants who occasionally volunteer in web-based research. Although the panel shows a slight overrepresentation of younger, higher educated people, its distribution of gender and geographic localization is comparable to the general Dutch adult population. Panel members received an invitation email with information about the study and with a link to the intervention website.

Study procedure
After entering the research website, reading the research information and giving informed consent, all potential participants were automatically assigned to one of three intervention conditions (1:1:1) by means of a digital randomizer built into the website. Randomization resulted in three equal groups of potential participants. As the next step, these individuals filled out the baseline questionnaire. Throughout the first part of this questionnaire individuals were asked about their age and about whether they were physically impaired. Those younger than 18 or older than 70 years and those who declared that they were physically impaired were removed from the study. Duplicate entries (based on identical IP addresses) also were removed from the study, as well as two individuals who gave highly unrealistic answers during the baseline questionnaire.

Interventions
Three SDT/MI applications in web-based CT were compared: (i) containing exclusively open-ended questions (OE), (ii) containing exclusively multiple choice questions (MC) and (iii) a containing both open-ended and multiple choice questions (OE&MC). The interventions were built exclusively for this pilot study. They were extensively technically tested and pretested.

All three interventions were text-based programs in which participants proceeded through several questions (open-ended and/or multiple choice). In the OE&MC condition participants were asked to categorize their open-ended answers through multiple choice questions.

The response categories for the multiple choice questions were derived from an (unpublished) explorative study in which 200 Dutch adults filled out a web-based questionnaire with open-ended questions about PA (for example, about perceived importance and confidence regarding regular PA).

At various instances participants received feedback messages containing a reflection or summary. In the OE condition, participants received messages in which generic feedback was supplemented with literal parts of their open-ended answers. In the MC and OE&MC conditions, the feedback messages were tailored on the answers to multiple choice questions, resulting in skillful reflections.

Figure 1 shows (simplified) examples of the tailoring mechanisms in the three intervention conditions. In the feedback message used in the MC and OE&MC condition, the participant’s multiple choice answers are combined into a highly specific feedback message. In the OE message, this high specificity is not possible and so this message contains literal quotes of the participant’s open-ended answers.

As mentioned above, the present study aims to take a first step towards integrating MI in web-based CT, and therefore focuses explicitly on two of the MI-specific counseling skills. Nevertheless, efforts were made to design the interventions as congruent as possible to both MI and SDT. Figure 2—adapted from Markland et al. (Markland et al., 2005)—shows how the interrelated elements of MI and SDT were integrated in the intervention.

Throughout the intervention, several aspects of PA were discussed. Participants received information about the Dutch PA guidelines and about their own current PA behavior. They were able to request additional information about the effects of regular physical activity in several domains such as physical health, mental health,
**OE**

How confident would you say you are that you could manage to increase your PA level? On a scale from 1 to 10, where would you say you are?

→ participant answers ‘5’

**Open-ended question:**
Your answer is 5. Why didn’t you choose a higher number? Complete the following sentence: ‘I’m not totally confident that I could increase my physical activity because...’

→ participant types ‘I’m very busy’

**Feedback message:**
So on the one hand, you’re not sure whether you’d manage to increase your physical activity. This is what you said about it: ‘I’m very busy’.

On the other hand you still have some confidence that you could increase your physical activity. This is what you said about it: ‘I do have a lot of perseverance’.

Do you already have some ideas about how you would increase your physical activity? With a good plan you would surely be able to become more physically active.

**OE&MC**

Your answer is 5. Why didn’t you choose a higher number? Complete the following sentence: ‘I’m not totally confident that I could increase my physical activity because...’

→ participant types ‘I’m very busy’

**Open-ended question:**
And why didn’t you choose a lower number?

Complete the following sentence: ‘I do have some confidence that I could increase my physical activity because...’

→ participant types ‘I do have a lot of perseverance’

**Multiple choice question:**
Which option best fits your answer to the previous question?

→ participant chooses option: ‘I do have some confidence that I could increase my physical activity because I have a very busy life’

**Feedback message:**
So you have a very busy life, and therefore you have less confidence that you could manage to increase your physical activity, which is completely understandable. However, you also said that you’re a real go-getter. When you have decided to do something, you go all the way! Because of that, you still have some confidence that you could increase your physical activity.

Do you already have some ideas about how you would increase your physical activity? What activity would you want to do? And how could you schedule this in such a way that it would not take too much time?

With your willpower and a good plan you would surely be able to become more physically active.

**MC**

Your answer is 5. Why didn’t you choose a higher number? Which of the following answer options best suits you?

→ participant chooses option: ‘I’m not totally confident that I could increase my physical activity because I have a very busy life’

**Multiple choice question:**
And why didn’t you choose a lower number?

Which of the following answer options best suits you?

→ participant chooses option: ‘I do have some confidence that I could increase my physical activity because I’m a real go-getter’

**Feedback message:**
So you have a very busy life, and therefore you have less confidence that you could manage to increase your physical activity, which is completely understandable. However, you also said that you’re a real go-getter. When you have decided to do something, you go all the way! Because of that, you still have some confidence that you could increase your physical activity.

Do you already have some ideas about how you would increase your physical activity? What activity would you want to do? And how could you schedule this in such a way that it would not take too much time?

With your willpower and a good plan you would surely be able to become more physically active.

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**Fig. 1:** Example of tailoring mechanisms and feedback messages.
physical appearance and social life. The importance of regular PA was discussed through elaborating on the relationship between the participant’s personal held values and regular physical activity, and by exploring the possible effects of regular physical activity, on the short and on the long term. Furthermore, attention was paid to the participant’s confidence (that he/she could succeed in becoming more physically active) by looking at personal strengths and positive experiences and by elaborating on tips and tricks to make it easier to become more physically active. Finally, participants could formulate their own specific action plan through a structured planning module. During this planning module, they received several tips, for instance about how they could best formulate realistic goals. They also could make their own coping plans (in which they were asked to anticipate on situations in which it would be difficult to become physically active).

**Questionnaire**

**Demographics**

At baseline, age, gender, weight, height and highest completed educational level were assessed. Educational level was categorized into high, middle and low education, according to the Dutch educational system.

**Physical activity**

At baseline, and follow-up 2 the number of days per week with sufficient PA was measured with a self-reported single item of the Dutch Short Questionnaire to Assess Health Enhancing Physical Activity (SQUASH): ‘On how many...’

<table>
<thead>
<tr>
<th>SDT</th>
<th>MI</th>
<th>Integration in the intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support autonomy (autonomy)</td>
<td>Avoid coercion / let the client make decisions about what and how to change</td>
<td>Feedback messages were written in an empathic, non-coercive way. Participants decide to skip the planning module of the intervention (planning module consists of both action and coping planning).</td>
</tr>
<tr>
<td></td>
<td>Roll with resistance</td>
<td>Example: low scores on the 1-10 importance ruler were acknowledged and validated using a simple reflection: ‘your answer is 1: so increasing your physical activity is not that important to you’.</td>
</tr>
<tr>
<td></td>
<td>Explore options</td>
<td>During the planning module, participants were stimulated to come up with their own ideas for exercise.</td>
</tr>
<tr>
<td></td>
<td>Encourage change talk</td>
<td>Change talk was prompted with on several ways (1-10 importance ruler, looking forward, asking about important values).</td>
</tr>
<tr>
<td>Provide structure (competence)</td>
<td>Present clear and neutral information about behavior and outcomes</td>
<td>Participants received information about personal PA behavior. Furthermore they were able to glance over information about the benefits of PA.</td>
</tr>
<tr>
<td></td>
<td>Help the client develop appropriate goals</td>
<td>During the (optional) planning module, participants were given tips about how to formulate realistic goals.</td>
</tr>
<tr>
<td></td>
<td>Provide positive feedback</td>
<td>Feedback messages throughout the intervention were formulated in a positive manner.</td>
</tr>
<tr>
<td></td>
<td>Support self-efficacy</td>
<td>Participant’s self-efficacy was assessed by means of a 1-10 confidence ruler. Individuals with low confidence received extra questions and feedback about their personal strengths.</td>
</tr>
<tr>
<td>Be involved (relatedness)</td>
<td>Express empathy / demonstrate understanding of the client’s position / avoid judgement or blame</td>
<td>Feedback messages were written in an empathic, non-coercive way.</td>
</tr>
</tbody>
</table>

Fig. 2: Overview of how the interrelated elements of SDT and MI were integrated in the intervention.
days a week are you moderately physically active for at least 30 min?” (Wendel-Vos et al., 2003).

**Motivation-related variables**

At baseline, follow-up 1 and follow-up 2, motivational regulation towards PA was assessed using the Exercise Self-Regulation Questionnaire (SRQ-E). The SRQ-E contains subscales that represent external regulation, introjected regulation, identified regulation and intrinsic motivation (Ryan and Connell, 1989). The Intrinsic Motivation Inventory (IMI) was used to assess the feelings that participants experienced while being physically active. The IMI encompasses the following subscales: interest/enjoyment, perceived competence, effort/importance, perceived choice and usefulness (McAuley et al., 1989). In addition, intention (Sheeran and Orbell, 1999) and commitment (Webb and Sheeran, 2005) toward being sufficiently physically active were assessed. The different concepts and their Cronbach’s alphas (derived from the data from this study) are described in Table 1.

**Perceived need support**

At follow-up 1, perceived need support (the degree to which the participant’s basic psychological needs were met by the intervention) was measured with an adapted version of the Health Care Climate Questionnaire (HCCQ) (Williams et al., 1996). For the purpose of this study, the HCCQ was adapted to assess need support in the context of a digital intervention. This concept is also described in Table 1.

**Table 1: Description of the assessed variables**

<table>
<thead>
<tr>
<th>Concept</th>
<th>Questionnaire</th>
<th># Items</th>
<th>Example question</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived need support</td>
<td>Health Care Climate Questionnaire (HCCQ)</td>
<td>15</td>
<td>During the program I was provided choices and options. Totally disagree (1) to totally agree (7)</td>
<td>0.93</td>
</tr>
<tr>
<td>External regulation</td>
<td>Exercise Self-Regulation Questionnaire (SRQ-E)</td>
<td>4</td>
<td>I try to exercise on a regular basis because others would be angry at me if I did not Totally disagree (1) to totally agree (7)</td>
<td>0.82</td>
</tr>
<tr>
<td>Introjected regulation</td>
<td>Exercise Self-Regulation Questionnaire (SRQ-E)</td>
<td>4</td>
<td>I try to exercise on a regular basis because I feel guilty if I do not exercise regularly Totally disagree (1) to totally agree (7)</td>
<td>0.76</td>
</tr>
<tr>
<td>Identified regulation</td>
<td>Exercise Self-Regulation Questionnaire (SRQ-E)</td>
<td>4</td>
<td>I try to exercise on a regular basis because I believe exercise helps me feel better Totally disagree (1) to totally agree (7)</td>
<td>0.83</td>
</tr>
<tr>
<td>Intrinsic motivation</td>
<td>Exercise Self-Regulation Questionnaire (SRQ-E)</td>
<td>4</td>
<td>I try to exercise on a regular basis because it’s fun Totally disagree (1) to totally agree (7)</td>
<td>0.85</td>
</tr>
<tr>
<td>Interest / enjoyment</td>
<td>Intrinsic Motivation Inventory (IMI)</td>
<td>7</td>
<td>Totally disagree (1) to totally agree (7) I enjoy being physically active very much</td>
<td>0.94</td>
</tr>
<tr>
<td>Perceived competence</td>
<td>Intrinsic Motivation Inventory (IMI)</td>
<td>6</td>
<td>Totally disagree (1) to totally agree (7) I think I am pretty good at physical activities</td>
<td>0.87</td>
</tr>
<tr>
<td>Effort / importance</td>
<td>Intrinsic Motivation Inventory (IMI)</td>
<td>5</td>
<td>Totally disagree (1) to totally agree (7) I put a lot of effort into physical activities</td>
<td>0.84</td>
</tr>
<tr>
<td>Perceived choice</td>
<td>Intrinsic Motivation Inventory (IMI)</td>
<td>7</td>
<td>Totally disagree (1) to totally agree (7) I believe I have some choice about being physically active</td>
<td>0.79</td>
</tr>
<tr>
<td>Value/usefulness</td>
<td>Intrinsic Motivation Inventory (IMI)</td>
<td>4</td>
<td>Totally disagree (1) to totally agree (7) I believe being physically active could be of some value to me</td>
<td>0.92</td>
</tr>
<tr>
<td>Intention</td>
<td></td>
<td>3</td>
<td>Are you planning to be sufficiently physically active? Not at all (1) to very much (10)</td>
<td>0.94</td>
</tr>
<tr>
<td>Commitment</td>
<td></td>
<td>3</td>
<td>How committed are you to being physically active regularly? Not at all (1) to very much (7)</td>
<td>0.83</td>
</tr>
</tbody>
</table>
Process evaluation

At follow-up 1, appreciation for the intervention was evaluated by measuring several appreciation dimensions. Participants were asked to indicate on a 5-point scale how interesting, attractive, personally relevant, understandable, trustworthy, believable, informative and motivating they perceived the content of the intervention to be. They were also asked to indicate on a 5-point scale whether the intervention had the right quantity of information and whether they felt annoyed by the texts or questions. These questions were derived from another PA CT intervention study (van Stralen et al., 2009). Additionally, participants were asked to indicate on a 7-point scale to what degree they felt like the intervention content was aimed at them personally, whether the intervention enabled them to express their own point of view, to what degree there were sufficient answering options during the intervention (MC and OE&MC conditions only) and to what degree the intervention elaborated on their own answers to the open-ended questions (OE and OE&MC conditions only). These questions were developed for the purpose of this study. Finally, all participants were asked to provide an overall appreciation score (minimum 1; maximum 10) for the intervention (van Stralen et al., 2009).

Statistical analyses

One-way analyses of variance (ANOVA) were conducted to explore variance in participant characteristics in the three study conditions. Potential group differences in PA behavior between the three groups on the follow-up 2 measurements were analyzed through an analysis of covariance (ANCOVA), using the PA baseline scores, gender, age, BMI and educational level as covariates. Potential group differences within the follow-up 1 and follow-up 2 scores of the motivation-related variables were assessed by means of three multivariate analyses of covariance (MANCOVA), evaluating (i) intention and commitment, (ii) the four SRQ-E subscales and (iii) the five IMI subscales, with the baseline scores, gender, age, BMI, educational level and baseline PA behavior as the covariates. The three MANCOVA’s were each followed by univariate ANCOVA’s to check for group differences in the individual variables. Potential group differences in perceived need support and process evaluation were analyzed through ANCOVA’s with gender, age, BMI, educational level and baseline PA behavior as covariates. For all the above-mentioned ANCOVAs that were significant, Bonferroni post hoc tests were performed.

RESULTS

Nine hundred and eighty-two individuals (47% female; age 48 ± 13.7) completed the baseline questionnaire and proceeded to their assigned intervention condition. No baseline differences were found between the three study conditions.

Immediately after completion of the intervention, participants filled in the follow-up 1 questionnaire. One month later, participants filled in the follow-up 2 questionnaire. Follow-up 2 measurements were completed by 465 participants or 47% of the baseline population (46% female; age 51 ± 13.2). Drop-out analyses showed that participants younger than 50 years old were more likely to drop out at 1 month (OR = 2.06, 95% CI: 1.59–2.66). There were no differences in drop-out rates between the three intervention conditions.

Table 2 shows the estimated marginal means and standard errors of the outcome variables. MANCOVA was significant for intention and commitment at follow-up 1, $F(4, 1284) = 2.48; p = 0.042$. A univariate ANCOVA, followed by post hoc Bonferroni comparisons, revealed that participants in the OE&MC condition scored significantly higher on commitment at follow-up 1 than those in the MC condition ($\delta = 0.21$). Participants in the OE condition scored borderline significantly higher on intrinsic motivation at follow-up 1 than participants in the OE&MC condition. No group differences were found on self-reported PA behavior at follow-up 2.

Table 3 shows the estimated marginal means and standard errors from the process evaluation variables and perceived need support. ANCOVA tests were significant for the items concerning personal relevance, possibility to express one’s own opinion, degree to which the intervention elaborated on one’s own answers and overall score. For the item concerning elaboration (which was not presented to the MC participants), participants in the OE&MC condition scored significantly higher than participants in the OE condition ($\delta = 0.35$ on a 7-point scale). Bonferroni post hoc tests revealed that OE&MC participants scored significantly higher on the item concerning expressing
Table 2: Estimated marginal means and standard errors of the outcome variables

<table>
<thead>
<tr>
<th></th>
<th>Follow-up 1 (n = 652)</th>
<th>Follow-up 2 (n = 465)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OE (n = 218)</td>
<td>MC (n = 223)</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>SE</td>
</tr>
<tr>
<td>Physical activity (days/week)</td>
<td>4.38</td>
<td>0.10</td>
</tr>
<tr>
<td>Intention and commitment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pillai’s trace = 0.015; F(4, 1284) = 2.48; p = 0.042**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intention</td>
<td>8.03</td>
<td>0.07</td>
</tr>
<tr>
<td>Commitment</td>
<td>5.80</td>
<td>0.05</td>
</tr>
<tr>
<td>SRO-E</td>
<td>Pillai’s trace = 0.024; F(8, 1276) = 1.94; p = 0.051**</td>
<td></td>
</tr>
<tr>
<td>External regulation</td>
<td>1.60</td>
<td>0.04</td>
</tr>
<tr>
<td>Introjected regulation</td>
<td>2.97</td>
<td>0.06</td>
</tr>
<tr>
<td>Identified regulation</td>
<td>5.76</td>
<td>0.05</td>
</tr>
<tr>
<td>Intrinsic motivation</td>
<td>5.45</td>
<td>0.04</td>
</tr>
<tr>
<td>IMI</td>
<td>Pillai’s trace = 0.025; F(10, 1272) = 1.58; p = 0.108**</td>
<td></td>
</tr>
<tr>
<td>Interest/enjoyment</td>
<td>5.60</td>
<td>0.03</td>
</tr>
<tr>
<td>Perceived competence</td>
<td>5.00</td>
<td>0.03</td>
</tr>
<tr>
<td>Effort/importance</td>
<td>5.35</td>
<td>0.04</td>
</tr>
<tr>
<td>Perceived choice</td>
<td>5.86</td>
<td>0.04</td>
</tr>
<tr>
<td>Value/usefulness</td>
<td>6.15</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Covariates are baseline value(s), baseline physical activity (days/week), gender, age, BMI, educational level.

*p-value concerns ANCOVA.

**p-value concerns MANCOVA.

***Post hoc analysis shows significant difference between indicated values (p < 0.025).
one’s own opinion ($\delta = 0.59$ on a 7-point scale) than did MC participants, and significantly higher on the item concerning overall score ($\delta = 0.34$ on a 7-point scale) than did those in the OE condition. The post hoc test concerning the item about personal relevance revealed no significant group differences.

**DISCUSSION**

The aim of this study was to assess which question/reflection format leads to the most favorable results in terms of effect on autonomous motivation and appreciation for the intervention in a web-based computer-tailored SDT/MI PA intervention, by (i) using open-ended questions (without skillful reflections), (ii) using multiple choice questions (with skillful reflections) or (iii) using both question types (with skillful reflections). It was hypothesized that the most favorable results in terms of effect on autonomous motivation and appreciation for the intervention would be obtained in the condition with both question types and skillful reflections.

Our hypothesis was confirmed with regard to appreciation for the intervention (participants in the OE&MC scored significantly higher on several process evaluation items compared with participants in the OE and the MC conditions). Concerning effectiveness of the intervention, the results were more ambiguous. On the one hand participants in the OE&MC condition scored significantly higher on commitment at follow-up 1 than participants in the MC condition. Participants in the OE condition, however, scored borderline significantly higher on intrinsic motivation at follow-up 1 than participants in the OE&MC condition. Since the MC condition in the current study was outperformed by the OE&MC condition in terms of effect on commitment, it appears that open-ended questions represent an important element in a web-based computer-tailored SDT/MI PA intervention. This conclusion fits well with SDT’s focus on autonomy support. Prior research has shown that several specific counseling behaviors are associated with autonomy support, such as providing opportunities for choice (Ryan et al., 2011). Indeed, by asking open-ended questions, the participant is offered more autonomy than when there are only predetermined answers from which to choose. By providing clients this autonomy, chances are bigger that he or she will ‘own’ the reasons for change (Ryan et al., 2011).
This is consistent with MI’s emphasis on asking open-ended questions as essential in order to encourage change talk, which in turn strengthens self-determined motivation (Miller and Rollnick, 2013).

Although the results suggest that open-ended questions are an important element in web-based MI, the OE condition scored lower on overall appreciation compared with the OE&MC condition. This suggests that focusing exclusively on open-ended questions negatively affects appreciation for the intervention. This finding is consistent with our assumption that the limited degree of specificity of the tailored feedback would lead to lower appreciation. This assumption was strengthened by the fact that participants in the OE&MC condition were more satisfied with the way in which the intervention elaborated on their own answers, when compared with the participants in the OE condition. An alternative explanation for the lower appreciation of the OE condition, however, is that participants might have expected that during the intervention they would be able to just click on the answers rather than having to type a response. Participants could have been irritated by the additional time and effort needed to answer all the open-ended questions, which might have decreased overall appreciation of this condition.

Although in this study no differences in dropout were found between the three intervention conditions, it is conceivable that less positive intervention evaluation may very well lead to more attrition, especially when it comes to programs with multiple intervention sessions (Brouwer et al., 2008; McCambridge et al., 2011). Since attrition ultimately impedes intervention effectiveness, the process findings of this study should be taken into account during the development of future web-based MI/SDT interventions (Geraghty et al., 2012).

No group differences were found in perceived need support. This could be explained by the measure used. In order to measure need support, an adapted version of the Health Care Climate Questionnaire (HCCQ) was used. The HCCQ is typically used for assessment with real-life counselors. For the purpose of this study, the HCCQ was adapted to assess need support in the context of a digital intervention. The resulting questionnaire, however, may not have been adjusted satisfactorily for use in digital interventions.

Some limitations have to be acknowledged. First, a control group was omitted in this study. As the primary purpose of the study was not assessment of intervention main effects but of group differences between the intervention conditions, there was no strict need for a control group.

Secondly, complete case analyses were conducted instead of intention-to-treat analyses. However, dropout did not differ between the three intervention conditions. As indicated by White and Thompson (White and Thompson, 2005), individuals with complete baseline data but follow-up data missing do not contribute information about the intervention effect and may therefore be excluded from analysis without causing bias. As dropout was somewhat higher among younger participants, age was included as a covariate in all analyses.

Thirdly, participating in this study was relatively demanding since the baseline measurement, intervention and post-measurement were all on the same day. This could have led to some irritation among the participants, for instance during the follow-up 1 questionnaire, thereby possibly impeding the validity of the results.

Lastly, PA behavior (which was not the primary outcome in this experiment) was measured with a single self-report item. Recent studies, however, provided support for the validity of the single-item measure used in this study (Milton et al., 2011; Milton et al., 2013).

CONCLUSIONS AND RECOMMENDATIONS

The present study was performed in order to determine which question/reflection format leads to the most favorable results in terms of autonomous motivation and appreciation for the intervention in a web-based computer-tailored SDT/MI PA intervention. The results illustrate that open-ended questions represent an important element in a web-based computer-tailored SDT/MI intervention. In order to optimize appreciation for the intervention, however, the inclusion of both questions types (accompanied by skillful reflections) seems most promising. Still, the optimal ratio between open and multiple choice questions should be subject of further research (in particular because participants in the OE condition scored borderline significantly higher on intrinsic motivation at follow-up 1 than participants in the OE&MC condition). Moreover, although the interventions in this study were designed as much as congruent as possible to MI,
this study only is a first step towards web-based MI. Asking open-ended questions and skillfully reflecting are important MI counseling skills, but they only cover a small part of the total MI picture. Future studies should further assess how the spirit, processes and skills of MI can best be incorporated in web-based CT.

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**REFERENCES**


Patrick, H. and Williams, G. C. (2012) Self-determination theory: its application to health behavior and...


