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Motivation, self-regulation and physical activity among patients with rheumatoid arthritis

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Chapter 7

General Discussion

Physical activity (PA) has been shown to benefit individuals with rheumatoid arthritis (RA). Moderate-intensity PA may reduce the risk of coronary heart disease, which is the leading cause of death among individuals with RA, and more intense, dynamic forms of PA have been shown to increase muscle strength and reduce disease activity, without deleterious consequences to articular structures [1]. As individuals with RA are largely sedentary, and therefore miss out on the benefits associated with a physically active lifestyle, the purpose of this dissertation project was to develop and pilot-test an intervention to increase PA among less-active patients with RA, which could be delivered within the context of existing outpatient-based RA treatment plans.

Based on a review of the literature, we wished to investigate the effects of this intervention, not only upon physical activity, but upon changes in fatigue, psychological distress, disease activity, and functional ability as well. Furthermore, as there is a gap in the literature in explanatory processes within behavior change and self-management interventions [2, 3], we wished to investigate, as fully as possible, the chain of mediations between intervention delivery and fidelity, changes in PA-related cognitions and self-regulation skills, changes in PA behavior, and changes in psychological and disease-related outcomes.

Identifying Intermediate Targets and Intervention Content

In order to identify intervention techniques and intermediate intervention targets which would best foster increases in physical activity among patients with RA, and which would potentially have knock-on effects on psychological and disease related variables, we conducted a number of preliminary investigations which are presented in chapters 2 and 3 of this dissertation.

Self-regulation skills

In chapter 2, we describe a systematic review and meta-analysis of 27 randomized controlled trials which tested psychological interventions among patients with rheumatoid arthritis. As a whole, this set of interventions had a significant medium-sized effect upon physical activity behavior, and had significant small effects upon the disease related variables pain and disability and the psychological variables anxiety and depressive symptoms.

In an effort to determine which intervention techniques were associated with improvements in these outcomes, we assessed all included studies for their use of 5 techniques derived from self-regulation theory: goal setting, action planning, self-monitoring, feedback and coping planning. In comparative analyses, we found that those studies which utilized more of these

self-regulation techniques had larger effects upon anxiety and depressive symptoms than those using fewer of those techniques. In addition, studies which produced increases in physical activity tended to include most of the self-regulation techniques we assessed. Based on these findings, and the well-documented role of self-regulatory processes in behavioral activation and maintenance [4, 5], we decided to target individuals' use of self-regulation skills as a predecessor of PA behavior and PA goal achievement.

To do so, we selected self-regulation coaching as a key component of the intervention. Self-regulation coaching engages individuals in behavioral goal setting, action planning and self-monitoring, and provides individuals with feedback as they pursue their goals. A number of meta-analyses indicate that the use of such techniques is vital in increasing physical activity [6, 7], and as such we developed a workbook for patients which incorporated these strategies.

Autonomous Motivation for PA

In a cross-sectional study which analyzed baseline data from the same study presented in Chapter 3 of this thesis, our research group identified autonomous motivation as an important predictor of physical activity in the short-term [8]. Autonomous motivation, or the extent to which one engages in behavior for personal as opposed to external reasons, is derived from self-determination theory [9] and is akin to the concept of goal ownership within self-regulation theory [5]. Across a number of chronic conditions and within healthy individuals, greater levels of autonomous motivation have been linked with important changes in health behaviors, including medication adherence, self-management behaviors, weight loss and physical activity [10-12]. Additionally, greater levels of autonomous motivation are believed to predict long-term engagement in leisure-time physical activity, as enjoyment is important in maintenance of physical activity behaviors [13].

To target increases in autonomous motivation, we included a motivational interview as one component of the intervention. Motivational interviewing (MI) is a client-centered form of counseling which has its roots in the treatment of alcoholism and drug addiction, but within the last decade, it has been frequently applied in interventions designed to change other health behaviors, including physical activity [14, 15]. There is also a growing body of (mainly theoretical) literature which links certain components of MI delivery (e.g. MI spirit) to changes in constructs derived from self-determination theory: Among them, autonomous motivation [16, 17].

Self-efficacy for PA

In Chapter 3 of this thesis, we analyzed longitudinal data from 271 individuals with RA and identified self-efficacy for physical activity as an important predictor of physical activity, in both the short- and long-term. Self-efficacy, or one's belief in his/her capabilities to achieve a desired state or perform a specific task, is derived from social cognitive theory [18], and is an important predictor of intention and behavior across several theories of behavior change [19]. The link we demonstrated between self-efficacy and physical activity behavior is congruent with the findings of many similar studies over the past decades [19].

To foster increases in self-efficacy for PA, we included intervention components designed to target Bandura's four sources of self-efficacy: past experience, vicarious experience, persuasion, and interpretations of somatic states [20]. According to Bandura, the strongest source of self-efficacy evaluations is an individual's own previous experience with a behavior. That is: positive and successful experiences with a behavior increase self-efficacy for subsequent performance of the behavior. We therefore included concrete action planning for short-term, realistic, personally relevant and enjoyable physical activity goals, which would increase the likelihood of positive experiences (i.e. enjoyment and achievement) with PA occurring.

To provide vicarious experiences with PA, the self-regulation workbook provided to patients contained quotes from patients with RA which indicated that other individuals similar to the reader (i.e. with RA) have become physically active in the past. Such quotes highlighted benefits individuals with RA had perceived after increasing their levels of PA, the ease with which they were able to integrate PA into their daily routines, and the value patients placed on using self-regulation techniques in relation to physical activity. Vicarious experiences were also provided through group discussions about PA facilitated in the patient education sessions during the first week of the intervention.

No efforts were made to increase self-efficacy through direct persuasion, as this technique may be counterproductive, decreasing the likelihood of behavior change and maintenance [21-23].

Finally, patients' interpretations of somatic states were targeted by teaching patients to differentiate between the types of sensations one might normally expect to experience when becoming physically active (e.g. muscle soreness, tightness, mild joint pain), and types of pain which indicate that joints may be incurring damage (e.g. severe pain, pain which persists longer than 90 minutes after activity).

Achievement of PA Goals

In addition to its link with increased self-efficacy evaluations, goal achievement is also linked directly to increases in physical activity behavior, provided of course that the goal targeted PA behavior. In Chapter 3 of this dissertation [24], we linked increased levels of self-efficacy and physical activity goal achievement to improved pain and quality of life among patients with RA. That is, the greater an individual perceived his or her ability to achieve a physical activity goal, the greater the likelihood that goal was eventually achieved, and the greater the chance of improvements in arthritis pain and quality of life. We hypothesized that these mediation effects through goal achievement operated in conjunction with patients' beliefs about the controllability of their RA through physical activity (i.e. treatment control)[25]. As goal achievement is linked to pain and quality of life outcomes, behavior, and as stated previously, to increases in self-efficacy, we included it as an additional target of the intervention.

To increase the likelihood of physical activity goal achievement, we developed the self-regulation coaching workbook to include an emphasis on realistic goal setting, goal laddering, action planning and coping planning, and trained nurse practitioners in ways to optimally provide feedback on goal progress, as these techniques have each previously been linked with goal achievement [5, 26].

Examining the Effects of the Intervention

Main Effects

In chapter 4 of this thesis, we report the results of a randomized controlled trial of our combined motivational interviewing and self-regulation coaching intervention. This study compared the effects of a group-patient education session, similar in content to what is already delivered in standard outpatient care for RA, to the effects of that same group education session plus one motivational interview delivered by a physical therapist and two self-regulation coaching sessions delivered by a rheumatology nurse practitioner with the aid of a workbook.

Based on power calculations conducted using data from a meta-analysis of physical activity interventions among individuals with arthritis and a randomized controlled trial conducted among sedentary individuals with RA, we recruited 78 patients to take part in the trial. Over the full 32-week course of the intervention (6 weeks for intervention delivery plus a follow-up of 6 months), there were significant effects of the intervention on the intermediate outcomes self-efficacy for PA and autonomous motivation for PA. In other

words, patients allocated to the intervention group improved these variables significantly more over the course of 32 weeks than did patients allocated to the control group. This confirmed that the techniques we systematically selected to comprise our intervention indeed had the intended effects upon these important cognitions which were thought to underlie sustained increases in physical activity.

The intervention also led to significant increases in minutes of leisure time PA and days per week with at least 30 minutes of moderate intensity PA. Patients in the intervention group increased their levels of leisure-time physical activity by an average of 90 minutes per week over the course of the intervention, compared to an average increase of only 5 minutes in the control group. The intervention group also reported being physically active for at least 30 minutes on 1.5 more days per week than they did at baseline. These changes are equivalent to the increases in physical activity demonstrated within our meta-analysis in chapter 2 of this thesis [6], and represent changes in behavior which would substantially reduce cardiovascular disease risk within these individuals [27].

At both post-treatment and follow-up, a significantly greater percentage of individuals in the intervention group met the 5 x 30 minutes recommendation for physical activity than within the control group. Two-thirds of patients in the intervention group met this recommendation at post-treatment, and fully half continued to do so at the six-month follow-up. This six-month level of physical activity maintenance is an improvement on the rate of PA maintenance achieved by an internet-based physical activity intervention (38%), which provided patients with a structured exercise regimen which they were told had to be completed 5 times per week [28]. The contrast between the instructive and controlled nature of that intervention, and the autonomy supportive nature of the one tested here, lends further support to the assertion that coercion and persuasion might be ineffective at creating lasting behavioral change [29].

In comparison to other interventions targeting increases in physical activity among patients with rheumatoid arthritis, the intervention developed and tested here is relatively brief. With roughly 4 hours of total contact time, including follow-up phone calls, the intensity of this intervention is less than half of some previous interventions in this area [30-33], yet the effects of the interventions on physical activity are of a similar magnitude. This leads us to believe that targeting both the motivation and action phases of behavior change provides added value, as several more resource-intensive interventions, which targeted only the action phase of behavior change, have produced only minimal

or null findings [31, 34, 35]. The significant effects of the intervention on both self-efficacy and autonomous motivation, as well as the previously demonstrated synergistic effect of combined motivational and volitional interventions [36], seem to indicate that these phases interact in producing the maintained increases in PA achieved here. The source of this interaction might be the long-term outcome goals set at the end of the motivational interviews, which were subsequently linked to the short-term behavioral goals set during the self-regulation coaching sessions, as this linking of outcome and behavioral goals has previously been linked to the efficacy of behavior change programs [37, 38].

Secondary Effects.

In addition to its effects on physical activity behavior, the intervention also led to short-term improvements in depressive symptoms and self-reported fatigue. At post-treatment, the intervention group had significantly reduced their levels of both depressive symptoms and fatigue from baseline, while levels within the control group remained roughly the same. Although these effects did not remain significant at the 32 week follow-up, the initial shift in these variables after 3 hours of contact time is promising, particularly when considering the probable floor effects which arose from the low levels of fatigue and depressive symptoms reported by both groups at baseline. In previous, more-intensive, intervention studies among patients with RA with high levels of fatigue, both a 12-week low-impact aerobic exercise program [39] and a 10-session regimen of cognitive behavior therapy [40] led to reductions in fatigue and improvements in mood. As both physiological and psychological pathways may lead to improvements in fatigue and depressive symptoms among patients with RA [41], more research would be necessary to determine which pathway was most responsible for the initial shift in these variables demonstrated by our relatively brief intervention.

Counter to our hypotheses, the combined motivational interviewing and self-regulation coaching intervention did not have any significant effects on disease activity or functional ability. Based on a meta-analysis of physical activity interventions among patients with arthritis [42], we had anticipated that changes in physical activity of the magnitude demonstrated by our intervention would be accompanied by at least small improvements in disease activity and functional ability. This lack of effect may have arisen from an incongruity between the types of PA participants undertook in this study (self-chosen, enjoyable, fun, and which they were autonomously motivated to do), and the types of PA that have led to improvements in these variables during more

structured PA interventions (suggested by others, possibly difficult or strenuous, and perhaps more likely to improve disease activity and functional ability). As this study was unable to provide any evidence for a link between increases in leisure time PA and improvements in disease related variables, further research is needed to approximate a dose-response relationship for leisure-time PA among patients with RA: both in general and across varying individual and disease-related characteristics (e.g. age, gender, disease duration, severity).

Investigating Processes within the Intervention

To gain insight into underlying intervention processes which contributed to the effectiveness of the intervention, we conducted two process evaluation studies: one investigating the effects of motivational interview treatment integrity upon regulatory style and physical activity, and the other investigating whether changes in cognitions following the intervention explained behavior change and maintenance.

Effects of MI Treatment Integrity

In chapter 5, we describe an evaluation of the quality of motivational interviews delivered within the context of this intervention, and how several indicators of MI treatment integrity related to changes in patients' regulatory style (motivation) and total physical activity one week after the MI session. Although the sample size for this study was small, it was novel, in that only two studies had previously investigated how MI treatment integrity affects physical activity outcomes [43, 44], and none had investigated whether MI treatment integrity is linked with variables derived from self-determination theory.

Prior to the start of the trial, three physical therapists received a training course of four 4-hour sessions, wherein the basic principles of MI were outlined and opportunities for practice and feedback were allotted before the beginning of the main trial. All participants received the Dutch version of the book *Motivational Interviewing in Health Care* [45], and the course largely followed the recommendations for progressive skills training in MI set forth by Miller and Rose [46]. Despite these efforts however, the MIs delivered during the intervention consistently fell short of proficiency levels suggested in the *Motivational Interviewing Treatment Integrity (MITI)* evaluation instrument [47], with only two of the 27 MI sessions coded with the MITI having been adjudged as adequately delivered. This lack of treatment integrity might be attributable to the long period of time (6 months) between the training course and the start of the trial, as the involved physical therapists had few opportunities to practice and maintain their MI skills with patients in the interim.

Despite the low levels of MI proficiency at baseline, we found that over the course of the intervention there was a trend for each physical therapist to improve his or her proficiency in the delivery of MI. This tendency toward improvement is likely attributable to the effects of practice, and to performance-related feedback given to the physical therapists after each MI session [48]. This feedback included the MITI scores from the coded MI session, as well as specific examples of MI-inconsistent behaviors and statements from the session, including instances where the therapist provided unsolicited advice to the patient, where change talk on the part of the patient went unrecognized, or where a patient's preferences were not adequately taken into account.

Although the physical therapists involved in the trial generally stated that the performance related feedback was helpful, it may have had unintended negative consequences on performance as well. Despite making efforts to emphasize and positively reinforce successfully delivered MI components, a majority of the feedback given to the therapists pointed out problems with the delivered MIs. This consistent negative reinforcement may have undermined the therapists perceived self-efficacy for delivering MI and reduced motivation for use of MI adherent techniques. When providing feedback to individuals new to delivering MI interventions, efforts should be made to ensure that feedback is framed in a way which promotes self-confidence. Future researchers may also wish to apply theory to the training of health professionals (in MI), as this may improve fidelity of delivered behavior change interventions [49].

When investigating relationships between characteristics of the delivered MIs and outcomes, we found that certain aspects of MI delivery were related to increases in physical activity. Individuals who received an MI which was more proficiently delivered and which had a greater percentage of reflections to questions were more likely to have increased their level of total physical activity following the MI session. These findings are in line with those of previous researchers who found that MI-consistent techniques were associated with increases in exercise following an intervention [44].

Finally, we found that characteristics of the delivered MIs were also related to changes in regulatory style, and in particular to introjected regulation (i.e. the extent to which an individual engages in physical activity to avoid external sources of disapproval or gain external approval, including avoidance of associated guilt or shame)[50]. Decreases in introjected regulation were associated with MIs with higher global spirit ratings and greater ratios of MI-adherent behaviors to MI-non-adherent behaviors. As introjected regulation is associated with adverse behavioral outcomes [51], those delivering MIs to

patients might consider focusing on global MI spirit, and on the avoidance of MI-non-adherent behaviors.

Mediation of Intervention Effects through Intermediate Targets

In a subsequent study which we describe in chapter 6, we investigated whether more favorable PA-related cognitions (autonomous motivation and self-efficacy for PA) and greater use of self-regulation skills led to increased achievement of PA goals and to changes in, and maintenance of, leisure-time PA behavior. Such investigations are vital in determining how complex psychological interventions impact upon outcomes, and to test whether theoretical predictors of behavior change indeed underlie such changes [52].

At post-treatment, individuals in the intervention group reported using the self-regulation skills action planning, problem solving and coping planning, self-monitoring, obtaining feedback, focusing attention on goal pursuit, remaining positive when faced with setbacks and self-reward more often than individuals in the control group. These results serve as a proof of concept for the utility of the self-regulation coaching sessions, as they fostered increased self-regulation of PA behavior which continued at six months follow-up.

To determine whether these between-groups differences in the use of self-regulation skills were responsible for the significant effects of the intervention upon physical activity behavior, we conducted mediation analyses which investigated the contributions of self-regulation skills, autonomous motivation and self-efficacy for PA to changes in goal achievement and leisure time PA. At post-treatment, higher levels of PA goal achievement were attributable to an increased use of self-regulation skills in the intervention group, but not to increases in autonomous motivation or self-efficacy. This finding corroborates those of previous researchers, who have indicated the importance of self-regulation strategies in achieving personally important (physical activity) goals [4, 5, 26, 53-56].

When investigating mediation effects upon changes in physical activity behavior, no significant relationships with leisure-time PA were found at post-treatment. However, at 6 months follow-up, the indirect effects of the intervention upon PA became stronger, as was hypothesized, with sustained levels of leisure time PA significantly attributable to both higher levels of autonomous motivation and an increased use of self-regulation skills. This finding indicates that individuals who had internalized their motivations for physical activity and had more often utilized strategies to focus on staying physically active were the ones who maintained their new physical activity patterns six months after the intervention. As maintenance of physical activity

may be crucial in reaching improved fitness and physical and psychological well-being [57], future research should investigate factors which contribute to continuation of the self-regulatory processes which appear to underlie PA maintenance. This might involve a focus on follow-up prompts [58] and additional research on social context of behavioral internalization [29].

Strengths and Limitations

Throughout the preliminary, intervention development, pilot-testing and evaluation stages of this project, efforts were made to understand and work within the constraints of existing outpatient care. By doing so, we have developed a minimally resource-intensive program which appears to be successful at increasing the proportion of patients with RA who meet the Dutch recommendations for healthy PA. As such, this program could be readily integrated into outpatient care across many RA outpatient treatment programs in the Netherlands, and with additional funding, could be modified and tailored to expand its reach even further. Before such broader implementation takes place however, the cost-effectiveness of this intervention will need to be assessed, particularly in light of the lack of effects the intervention had upon functional and disease related variables.

The intervention developed within this dissertation also benefits from the strong theoretical base upon which it was developed, and the efforts which were taken to test the underlying theory in its evaluation. Based on suggestions from Michie and Prestwich [52], we selected the intermediate targets of the intervention (i.e. cognitions, skills) using the findings of existing literature and data from our preliminary investigations, which demonstrated these variables as predictors of physical activity. After selecting the intermediate targets, we developed the content of the intervention by selecting techniques which were either assumed to have an impact on these intermediate variables, or which had had a demonstrable effect upon these variables in previous research. We avoided including intervention techniques which were not thought to have an impact upon the intermediate intervention targets. Finally, after having implemented the intervention, we made efforts to determine whether the mediating effects assumed during intervention development were present in vivo. While the intervention study was perhaps not adequately powered to properly test mediation, by doing so, we carried out many of the range of procedures suggested by Michie and Prestwich and others in developing and testing theory-based behavior change interventions [52].

Despite its practicality, capability for broad ranging application and solid theoretical base, this dissertation has several limitations: mostly with

regard to processes within the intervention study. First, while adequately powered to detect changes in physical activity and changes in the proportion of individuals meeting the NNGB recommendations, the 158 patients who took part in the intervention meant that our testing of the full chain of mediations we had hypothesized, including the investigations in Chapters 5 and 6 of this thesis, were underpowered. While we had initially intended to recruit a larger sample of patients to take part in the study, thereby increasing our capability to test such mediations, our stringent inclusion criteria meant that we excluded nearly half of the 1251 patients we initially approached to participate. Future research should be adequately powered to detect whether intervention participation leads to changes in skills and cognitions, which leads to increases in physical activity behavior and subsequently to improvements in disease related variables. After conducting power calculations, preliminary proof of concept and feasibility studies can be used to test and refine materials and recruitment strategies in order to identify any necessary changes to processes and to determine whether enough participants are available within a particular setting, or whether the pool of potential participants needs to be expanded by involving additional institutions.

Within the study described in Chapter 5, a number of issues limit the reach of our findings. First, of the 36 motivational interviews conducted as part of the intervention, we were only able to analyze the content of 27 (75%) of them due to device malfunctions, user errors, and the voice recorders being misplaced. The low number of coded motivational interviews coupled with the primarily exploratory nature of the study meant that multiple comparisons greatly increased the chance of Type I error (i.e. finding significant correlations between characteristics of the MI sessions and changes in patients' PA behavior where none actually exist). While the findings from this study are novel, some of the significant correlations we found could be due to chance. Future investigations in this important area should be adequately powered for multiple comparisons. Furthermore, the fact that some of the MI sessions were not coded meant that the physical therapists were not able to receive feedback on their performance from these sessions. As a majority of the unrecorded MI sessions were in the early phases of the trial, it is unclear whether receiving more feedback at an earlier stage would have accelerated the rate at which therapists improved their skills in MI delivery, or would have increased MI fidelity at the end of the trial. Future research in this area should pay attention to recording the full set of patient-provider interactions so that the unfolding process of learning MI can be uninterrupted and more adequately and accurately assessed.

The problems with MI treatment integrity outlined in Chapter 5 lead one to question the extent to which the motivational interviews contributed to the effects of the intervention upon autonomous motivation and physical activity. We cannot rule out the possibility that the MI sessions were wholly ineffective, and that gains in physical activity and motivation were due only to the self-regulation coaching components of the intervention. At the same time however, we cannot rule out the possibility that motivational interviews which do not meet predefined standards of fidelity might still have an effect upon behavior and/or cognitions, and the possibility also remains that a component of the motivational interviews not accounted for in our coding process is actually responsible for the efficacy of the intervention. In future studies investigating the use of a specific set of counseling techniques, the uniformity and fidelity of delivery across a number of providers should be attained before proceeding to a larger scale trial. This issue has been cited as particularly problematic when behavior change programs are more broadly implemented outside of academic settings [59].

Future Directions

This dissertation outlined the development and testing of a theoretically derived intervention, which increased leisure time physical activity among individuals with rheumatoid arthritis who did not meet public health recommendations for physical activity. While this is promising, many questions regarding the ideal methods for physical activity promotion among patients with RA remain unanswered.

The randomized controlled trial presented in chapter 4 of this dissertation compared the effects of patient education, motivational interviewing and self-regulation coaching to patient education alone. While this study design provided some evidence for the importance of motivation in promoting PA, further research should investigate the importance of the motivation phase in a full-factorial design in order to determine whether either motivational interviewing or self-regulation coaching alone are sufficient to create lasting behavioral change, or rather, as has been hinted at elsewhere [36], that it is indeed the combination of the two which is necessary to do so. Only through the extended use of such methodologies can the science of behavior change advance beyond its history of so-called 'black box' experimentation in trials testing multicomponent behavioral interventions [60].

While the intervention developed and tested here did increase leisure-time PA and the percentage of individuals achieving the recommend 5 x 30 minutes of PA per week, it did little to investigate which types of physical activity are most likely to improve functional and disease-related outcomes within

individuals with RA. As there were minimal shifts in disease activity or functional ability resulting from the combined motivational interviewing and self-regulation coaching intervention, we were unable to identify modalities and patterns of PA engagement (e.g. daily walking, intensive cycling, or occasional low-intensity sport) which might have correlated with improved function or disease activity. As developing a dose-response relationship for the alleviation of symptoms and improvement of functional outcomes through physical activity is vital in determining the cost-effectiveness of such interventions, future research should investigate this in a controlled way, particularly among physical activity modalities which patients with RA most often find enjoyable. This is important in ensuring that individuals expend effort toward increasing activities which will not only produce measurable gains, but will also be enjoyed, and therefore better maintained in the long term.

With regard to long-term maintenance of physical activity, future research in this area should consider additional ways to increase use of self-regulatory processes after face-to-face components of interventions end. Within this study, we utilized three follow-up phone calls spaced at six-week intervals to prompt individuals to continue setting goals, making plans and self-monitoring their behavior. This led to a maintained use of nearly all self-regulation skills we examined (self-monitoring, action planning, coping planning, obtaining feedback, and attention and emotion control). Recent advances in technology might allow individuals to continue self-regulating their behavior even longer after the treatment period ends. Such advances include smartphone applications which allow users to continually track their physical activity via on-board and/or external accelerometers, and can subsequently provide users with feedback and prompt users to set goals and create action and coping plans. While some applications like this are presently available, further refinement of these devices is needed to increase usability and to ensure consistency and accessibility across various firmware platforms, as well as to verify the quality of the physical activity data such applications collect. In addition, future researchers may wish to include some sort of training in the use of these materials for patients involved in trials, and should test these applications against traditional pen and paper self-regulation materials to determine whether the mobile versions are indeed better at increasing maintenance.

As healthcare resources continue to be stretched, and the time healthcare practitioners are allotted to treat each patient is further constrained [61], brief and internet-based interventions will become the new standard of care. While brief and internet-based volitional interventions as described above have received considerable attention within the literature [62], the same is not

true of motivational interventions. Research into brief and online motivational interventions, including motivational interviewing [63], is therefore a necessary prerequisite to developing interventions which target both phases of behavior change, and which are compatible with this approaching wave of limited resources.

Finally, when training health care professionals or laypersons to deliver behavior change interventions, researchers would be well served to place a greater emphasis on the process of behavior change within the individuals being trained. The theoretical constructs which underlie behavior change in health-related domains (e.g. smoking cessation, physical activity engagement) likely also underlie changes in professional behavior [49]. A more dedicated theory based approach to training programs which involves measuring constructs related to intervention delivery (e.g. self-efficacy, motivation), as well as thorough and detailed investigations of actual behavior during patient-provider interactions, could do much to shed light on the full chain of mediations between aspects of the training, aspects of intervention delivery and eventual changes in patient behavior [64].

Conclusions

Within this dissertation, we found that an intervention which combined group patient education, motivational interviewing and self-regulation coaching produced greater gains in leisure-time physical activity and adherence to Dutch physical activity recommendations than did patient education alone. The intervention also led to improvements in autonomous motivation, self-efficacy for physical activity, and to an increased use of self-regulation skills over the course of the intervention – changes which are most likely responsible for the initial and sustained effects upon physical activity.

By integrating information about the existing nature of outpatient care, and by conducting preliminary research to establish a full chain of hypothesized relationships from intervention techniques, to cognitions and skills, and through to shifts in PA behavior, the brief intervention we developed is both theoretically sound and ready for the real world. While many questions remain unanswered about the types of physical activity which most benefit patients with rheumatoid arthritis, this dissertation has laid the foundation for potential integration of self-regulation based leisure-time physical activity interventions in existing outpatient care, and can be further modified and adapted in light of changing circumstances and new insights into the relationships between physical activity modalities and improvements in disease-related variables among individuals with rheumatoid arthritis.

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