A Case Study: The Self-Determination Theory and the integration of smartphone technology to enhance adherence to home exercise programs

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ABSTRACT

Background and Purpose: The Self-Determination Theory (SDT) is a theory that describes self-controlled motor learning and can be utilized by physical therapists to better understand the psychological factors that contribute to patient compliance. Physical therapists may be able to apply the SDT by utilizing smartphone technology to assist in patient education and motivation by recording the patient’s home exercise program on their smartphone. The purpose of this case report is to demonstrate how the SDT was used to integrate smartphone technology into patient education and to enhance patient adherence to a home exercise prescription.

Case Description: The patient is a 20 year-old female with a diagnosis of right Internal Coxa Saltans, who was referred to physical therapy by her physician. The patient qualified for the study based on her need for physical therapy services, her ownership and competence with a smartphone, and her willingness to participate in the study. Ethical approval for the study was granted by the Ithaca College Review Board for Human Subjects Research.

Outcomes: Outcome measures included the Intrinsic Motivation Inventory (IMI) questionnaire, a compliance log, and patient attendance at physical therapy services. The IMI scores indicate a low intrinsic motivation related to interest/enjoyment, and moderate intrinsic motivation regarding value/usefulness and perceived enjoyment. The patient was present at all therapy sessions; her compliance logs indicated that she was confident with her exercises and that she performed her exercises as prescribed by her therapist.

Discussion: Based on the patient’s low-to-moderate intrinsic motivation and her high rate of compliance and competence regarding her exercise program, it is reasonable to infer that the smartphone video influenced the patient’s motivation and adherence to her exercise program. Further research is required to demonstrate a direct correlation between smartphone video technology and patient compliance with home exercise programs.
Key Words: Compliance, Adherence, Home Exercise Program, Physical Therapy, Internal Coxa Saltans, Motivation, Intrinsic Motivation, Extrinsic Motivation, Self-Determination Theory

METHODS

Background and Purpose
A positive relationship has been shown between adherence to exercise programs and the patient’s functional outcomes (Mannion, Helbling, Pulkovski & Sprott, 2009; Chen, Neufeld, Feely & Skinner, 1999; Fisher, 1990). A home exercise program enables the patient to have greater responsibility over his or her treatment. Adherence to a home exercise program is dependent on many variables. Among these are the patient’s confidence, motivation, relationship with the therapist, rehabilitation coping ability and social support (Levy, Polman, Clough, 2008; Fisher, 1990; Hall, Ferreira, Maher, Latimer & Ferreira, 2010). There have been many theories that examine the psychological factors contributing to patient compliance. Among these theories, the Self-Determination Theory (SDT) is a foundation for understanding self-controlled motor learning.

Self-Determination Theory is a macro-theory that encompasses three separate micro-theories. The first of the three micro-theories is the Basic Psychological Needs Theory (Sanli, Patterson, Bray & Lee, 2012; Ryan & Deci, 2007). The three basic psychological needs that can enhance the quality of motivation are autonomy, relatedness, and competence. Autonomy refers to the willingness and choice an individual has to perform an activity; relatedness is the feeling of closeness to other people; and competence is the feeling that an individual can master the challenge and effectively interact with the environment (Sanli et al., 2012; Katz & Assor, 2007). Differences among individuals in satisfying each of the three basic psychological needs will impact motivation towards a specific activity (Ryan & Deci, 2007). Therefore, if therapists ensure that these psychological needs are met, the patients are more likely to be motivated during physical therapy interventions.

The second micro-theory that is part of the SDT is the Cognitive Evaluation Theory, which involves an individual’s intrinsic and extrinsic motivation to perform a behavior as influenced by personal beliefs and environmental factors (Sanli et al., 2012). Intrinsic motivation refers to the participation in an activity for the purposes of satisfaction, enjoyment, and interest (Deci et al., 1996; Duda, 2010). For example, athletes who are intrinsically motivated are said to play their sport “for the love of the game” (Smith, 2010). In contrast, extrinsic motivation requires an outside factor such as avoiding guilt, obtaining approval, receiving an award or avoiding a punishment (Deci et al., 1996). Generally, rehabilitation would be classified as an extrinsically motivated behavior. Patients perform exercises to improve function, reduce pain, avoid guilt, and please their therapist, all of which would be classified as extrinsic factors influencing motivation. However, in some therapeutic interventions where wellness is the goal, intrinsic motivation has been shown to be the key factor in determining patient outcomes (Power, Ullrich-French, Steele, Daratha & Bindler, 2011). Therapists who understand
that their patients will require more extrinsic motivation to complete exercises may be more creative when prescribing home exercise programs for their patients.

The third aspect of SDT is the Organismic Integration Theory. This theory divides extrinsic motivation into a continuum of four types of behavior regulation (Figure 1). External regulation is on one end of the continuum, representing activities that are imposed due to external demands or dependent on punishments or rewards (Deci et al., 1996).

The next type of behavior is introjection, which includes activities controlled by internal demands such as avoiding guilt or embarrassment followed by identified regulation behaviors, which involve activities that are performed because the person believes they are important and may help achieve specific individual goals (Deci et al., 1996). The last behavior on the continuum is closest to intrinsic motivation. Integrated regulation refers to activities that are integrated within the person’s sense of self and therefore performed freely (Deci et al., 1996). This is different than intrinsic motivation because the activity is not performed for the sake of the activity itself, but rather there is an alternative motivational factor that relates to the person’s sense of self. As behaviors move along the continuum towards integrated regulation, the amount of commitment and autonomy increases. Ideally, therapists hope to move patients along the continuum; pushing patients from external regulation behaviors where the patient performs their exercises to avoid a lecture from the therapist towards integrated regulation behaviors where wellness is a part of the patient’s sense of self and so the patient is motivated to exercise. Patients who demonstrate behavior approaching integrated regulation on the continuum are more likely to demonstrate commitment, autonomy and adhere to exercise programs.

Figure 1
Extrinsic Motivation Continuum of Behavior Regulation

(Deci et al., 1996)

Physical therapists can utilize the SDT to understand a patient’s potential adherence to a home exercise program. Patients who feel they have autonomy, relatedness, and competence regarding their exercises will be more likely to complete the prescribed exercises at home. Patients who believe their exercises will help them achieve their goals will be more committed to their home programs than patients who are performing exercises to avoid feeling guilty. The challenge is applying the knowledge of SDT to improve the patient’s extrinsic motivation. Utilizing digital media may enhance the patient’s feelings of competence and enjoyment during an exercise. The use of media through DVD and videotapes to enhance compliance to home programs has been used effectively to support a variety of patient conditions (Kingston, Gray & Williams, 2010). Smartphone usage has continued to grow within the United States, as evidenced by the statistic that during the three-month period from March to May 2013, more than three out
of five people owned a smartphone (“Mobile Majority”, 2013). Therefore, the purpose of this case report is to demonstrate how the SDT may be used to integrate smartphone technology into patient education with the goal of improving patient adherence to a home exercise prescription. Based on previous studies regarding SDT and patient motivation (Deci et al., 1996) the authors hypothesized that the patient would have increased confidence and perceived competence when performing her home exercise program because she had the ability to view her program on her smartphone and therefore her extrinsic motivation would improve.

Examination

The patient was a 20 year-old female referred to physical therapy with a diagnosis of Internal Coxa Saltans on the right side. Internal Coxa Saltans is also referred to as “snapping hip syndrome” and can be caused by the iliopsoas tendon snapping over the structures deep to it. These structures include the femoral head and the anterior capsule of the hip, and the snapping may lead to a painful lesion (Allen & Cope, 1995). The patient complained of right-sided hip pain and an occasional “snapping sound.” In the patient history, she reported that she was in “excellent” general health, and exercised at least three times per week. She had not had any surgeries and was not taking any medications. She reported that she had seasonal allergies, but denied a history of any other medical conditions including cancer, heart problems, and high blood pressure. She did not report any sleep disturbances or feelings of depression or hopelessness. The patient had been treated in physical therapy for a torn triangular fibrocartilage complex (TFCC) a year prior to this incident, but did not describe any recurring symptoms in her wrist. She stated that her hip symptoms occurred gradually and had grown progressively worse within the past month. She received physical therapy in 2010 for similar symptoms in the same hip. Radiographic studies in the form of an x-ray were performed prior to her referral to physical therapy, which did not indicate any abnormalities. She had seen an orthopedist, who recommended skilled physical therapy services. She graded her average level of pain over 48 hours at a 5/10 on the visual analog scale (VAS) scale, where 0= no pain and 10= worst pain imaginable. She also indicated that her function was a 9/10, where 0= cannot do anything and 10= able to do everything. Activities such as standing, sitting, and walking for long periods of time aggravated her symptoms. The patient stated that she could not “get comfortable lying down” although her sleep was not disturbed by her condition. The patient’s goals for physical therapy included reducing her hip pain and being able walk for long distances without pain.

A physical therapy initial examination was performed at the Ithaca College Occupation and Physical Therapy Clinic. The patient reported pain with active flexion and extension of her right hip joint, and trunk side-bending to the left. All other lower extremity motions were within functional limits both passively and actively. The patient’s lower extremity strength was deemed within normal limits bilaterally based on resisted tests and manual muscle tests. Flexibility tests were performed in the form of the Thomas Test and the 90-90 Straight-Leg Raise Test. Both tests resulted in positive signs indicating decreased flexibility and possible shortening of her rectus femoris, iliopsoas, and hamstring muscles. Based on her physical therapy examination and evaluation, the
patient demonstrated a need for skilled physical therapy services and was considered to be an appropriate candidate for this study.

Clinical Impression

The patient was appropriate for the application of the SDT through smartphone videos for several reasons. The patient demonstrated a need for skilled physical therapy services as determined by her physician referral and physical therapy examination and evaluation. She was willing to participate in the study and complete the related questionnaires each week. She also owned and used a smartphone and was willing to allow the researcher to take video recordings on her smartphone. The implementation of the SDT approach would be measured through weekly compliance logs related to the patient’s specific home exercise program, and the completion of an Intrinsic Motivation Inventory (IMI) questionnaire each week (McAuley, Duncan, Tammen, 1987) (See Appendix A) If the SDT was successful, the patient should demonstrate compliance with her exercise program and report confidence in her ability to complete her exercises appropriately. The patient’s intrinsic motivation level may or may not vary throughout the course of her rehabilitation.

Approach

The patient was treated with physical therapy interventions intended to decrease right hip pain, improve lower extremity strength, and increase flexibility. As a part of her physical therapy treatment, she was prescribed an individualized home exercise program. A research assistant used the patient’s smartphone to record the patient performing the exercises correctly. The patient was provided with a compliance log (See Appendix B) that included a list of her exercises along with the prescribed intensity and volume (See Table 1). The compliance log included two questions with both a multiple-choice option and an opportunity to write in any additional information. The first allowed the patient to indicate any reasons for not completing an exercise. The second examined the patient’s perceived confidence in performing the exercises correctly. The patient was also given a detailed home exercise program created by the ExercisePro version 5 (BioEx Systems Inc, n.d.), the computer program utilized in the Ithaca College Occupational and Physical Therapy Clinic. The intrinsic motivation inventory questionnaire was completed prior to beginning physical therapy services and then again each week to monitor any changes, and to gain a more accurate representation of her average level of intrinsic motivation throughout the course of her physical therapy treatment.
Table 1
Sample exercises prescribed during one week of patient’s therapy

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Details</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamstring stretch in long sitting</td>
<td>3 x 30 second hold</td>
<td>Once per day</td>
</tr>
<tr>
<td>Hip flexor stretch</td>
<td>3 x 30 second hold</td>
<td>Once per day</td>
</tr>
<tr>
<td>Resisted hip external rotation in side-lying</td>
<td>Red- elastic band 3 x 10 repetitions</td>
<td>Every other day</td>
</tr>
<tr>
<td>AROM Lumber alternate Leg/Arm (bird dog)</td>
<td>2 x 10 repetitions</td>
<td>Every other day</td>
</tr>
<tr>
<td>Resisted hip flexion in standing</td>
<td>Blue elastic 2 x 8 repetitions</td>
<td>Every other day</td>
</tr>
<tr>
<td>Resisted hip extension in standing</td>
<td>Blue elastic 2 x 8 repetitions</td>
<td>Every other day</td>
</tr>
<tr>
<td>Hip Adductor Stretch</td>
<td>3 x 30 second hold</td>
<td>Once per day</td>
</tr>
<tr>
<td>Hip abduction with knees bent in side-lying (clam shells)</td>
<td>Blue elastic 2x8</td>
<td>Every other day</td>
</tr>
</tbody>
</table>

Outcomes

The outcome measures used in this study included the compliance log that the patient completed each week, the number of times the patient participated in physical therapy, and the IMI. The IMI has been shown to be reliable and valid in a study performed by McAuley, Duncan, and Tammen (1987). The IMI is a multidimensional questionnaire that examines the participant’s perspective of their interest/enjoyment, value/usefulness, and perceived enjoyment when performing an activity. Table 2 demonstrates the IMI scores that the patient received each week and the mean score in each subsection. The IMI scores indicate a low intrinsic motivation related to interest/enjoyment, and moderate intrinsic motivation regarding value/usefulness and perceived enjoyment. The patient did not cancel any appointments during the course of her treatment.

Based on the compliance logs completed each week, the patient indicated that she performed her home exercise plan as directed by her therapist. When asked, “If you did not complete any of the exercises, why not?” she answered that she forgot once, and ran out of time once. The second question asked, “How confident did you feel that you were performing your exercises correctly?” The patient answered with the option, “very confident, ‘I remember how to perform each exercise correctly’” each week. The patient’s self-reports on the compliance log are consistent with the weekly SOAP notes completed by her therapists. Based on the outcome measures utilized in this study, the patient demonstrated adherence to her home exercise program as prescribed by her therapist.
Table 2
IMI Questionnaire scores

<table>
<thead>
<tr>
<th></th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest/Enjoyment</td>
<td>.196</td>
<td>.245</td>
<td>.286</td>
<td>.320</td>
<td>.262</td>
</tr>
<tr>
<td>Value/Usefulness</td>
<td>.683</td>
<td>.667</td>
<td>.635</td>
<td>.698</td>
<td>.671</td>
</tr>
<tr>
<td>Perceived Enjoyment</td>
<td>.482</td>
<td>.840</td>
<td>.714</td>
<td>.518</td>
<td>.639</td>
</tr>
</tbody>
</table>

Note: Values closer to 1 indicate a greater agreement to the concept described in the subscale.

DISCUSSION

In a society driven by social media and attachment to personal technology, physical therapists may be able to utilize a patient’s smartphone to enhance adherence to rehabilitation programs. In this case study, the patient was able to use her smartphone to view herself performing her exercise program correctly. The author hypothesized that having her home exercise program available on her phone would improve her confidence and perceived competence towards her exercises, thus improving her motivation. College students typically have their smartphones with them at all times; therefore, she was never without her home exercise program. The self-determination theory indicates that if a participant feels autonomous, relatedness, and competence while performing an activity, he or she will be more likely to feel motivated to participate in that activity (Deci et al., 1996). The smartphone video was utilized as an application of the SDT. A video of her home exercise program would enhance the patient’s feelings of competence and could be used to improve the patient’s motivation and adherence to her home exercise program.

The compliance logs the patient completed were strongly indicative of a high level of adherence to the program prescribed by her physical therapist. The patient diligently attended physical therapy sessions, completed her exercises as prescribed each week, and reported a high level of confidence in her ability to perform the exercises correctly on her compliance logs. While there is not enough evidence to determine if her high level of compliance was directly correlated to the smartphone videos, it is reasonable to infer that the videos played a role in her high level of confidence in performing her exercises correctly. In a 2004 study by Reo and Mercer, the authors examined the accuracy of patients performing exercises after various methods of instruction. The study determined that patients who received a handout alone were twice as likely to perform errors than patients who received video and live instructions. If the patient is performing the exercise properly, the patient’s perceived competence will be higher and therefore according to the SDT, so will the patient’s motivation.

The IMI provides insight into the patient’s own perceptions of her involvement in the home exercise program. Intrinsic motivation typically varies depending on a variety of internal and external factors. This patient’s IMI each week also varied within each subcategory. However, using the mean values shown in Table 2, the patient’s average level of intrinsic motivation towards her home exercise program can be determined. The
patient reported low levels of interest/enjoyment, and higher levels of value/competence and perceived enjoyment. A more detailed evaluation of the IMI data indicated several promising trends. The patient’s interest/enjoyment improved slightly throughout the 4 weeks, as did her level of perceived enjoyment. However, it is possible these trends may be due to other factors such as the patient’s decreased pain. Future studies that involve a greater number of subjects are required to determine the significance of the trends in this data. The SDT describes intrinsic motivation as performing an activity the purposes of satisfaction, enjoyment, and interest (Deci et al., 1996; Duda, 2010). The patient’s IMI related to interest and enjoyment was fairly low, which indicates that she did not have a high level of intrinsic motivation towards her home exercise program (McAuley et al., 1987). It is reasonable to assume that most patients who perform physical therapy home exercise programs are also not performing the activities for the sole purpose of enjoying the activity. Therefore, the goal for physical therapists trying to improve patient adherence needs to include ways to provide extrinsic motivation and assist in moving the patient along the extrinsic motivation continuum described above (Figure 1).

The patient’s high level of compliance, despite her low levels of intrinsic motivation, suggests that there were external factors that improved her motivation. The smartphone video was designed to enhance the patient’s perceived competence; she could be certain that she was performing her exercises correctly because she had a visual reference with her. Utilizing the patient’s smartphone allowed her home exercise program to become more convenient. The smartphone video may have assisted in moving her along the external motivation continuum. If she performed the activity because she felt that it was important, and may help her achieve goals of decreased pain and improved function, she would have demonstrated identified regulation behaviors (Deci et al., 1996). In a study performed at the University of North Carolina at Chapel Hill, patients who received exercise handout instructions made twice as many mistakes after one day than the group that received videotape or individualized demonstrations (Reo & Mercer, 2004). The use of a video viewable on a smartphone therefore could have an effect on patient compliance and exercise techniques. After initially improving in therapy, the patient’s condition began to decline by the fourth week of therapy and she was referred back to her physician. Because of the patient’s involvement in the study and her high level of compliance, the therapists felt confident that her lack of improvement was not due to a lack of compliance. With this patient, the high level of compliance ensured she received the additional care that she required to achieve the best possible outcome.

Future research determining a direct correlation between smartphone video technology and patient adherence to home exercise programs is needed to confirm the results of this study. The patient in this study was a college student who was very comfortable using the technology available on her smartphone. Patients who own smartphones but are not as familiar with the technology may have different outcomes. Many applications designed for both physical therapists and patients have become available to deliver home exercise programs via a patient’s smartphone (RevoPT, 2013; FORCE Therapeutics, 2013). Further study is required to test the specific applications, however the results of this case study indicate that these products may be worth trying. In conclusion, the findings from this case study are consistent with other research regarding video and adherence to exercise programs. Physical therapists may be able to incorporate
the use of smartphone technology to assist in patient adherence to home exercise programs that has the potential to positively impact patient outcomes.

Acknowledgments

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REFERENCES


Appendix A: Intrinsic Motivation Inventory

ACTIVITY PERCEPTION QUESTIONNAIRE
The following items concern your experience with the exercises in your home exercise program. Please answer all items. For each item, please indicate how true the statement is for you, using the following scale as a guide:

1        2         3          4         5       6       7
Not at all true       Somewhat True           Very true

1. I believe that doing this activity could be of some value for me.
2. I believe I had some choice about doing this activity.
3. While I was doing this activity, I was thinking about how much I enjoyed it.
4. I believe that doing this activity is useful for improved concentration.
5. This activity was fun to do.
6. I think this activity is important for my improvement.
7. I enjoyed doing this activity very much.
8. I really did not have a choice about doing this activity.
9. I did this activity because I wanted to.
10. I think this is an important activity.
11. I felt like I was enjoying the activity while I was doing it.
12. I thought this was a very boring activity.
13. It is possible that this activity could improve my studying habits.
14. I felt like I had no choice but to do this activity.
15. I thought this was a very interesting activity.
16. I am willing to do this activity again because I think it is somewhat useful.
17. I would describe this activity as very enjoyable.
18. I felt like I had to do this activity.
19. I believe doing this activity could be somewhat beneficial for me.

20. I did this activity because I had to.

21. I believe doing this activity could help me do better in school.

22. While doing this activity I felt like I had a choice.

23. I would describe this activity as very fun.

24. I felt like it was not my own choice to do this activity.

25. I would be willing to do this activity again because it has some value for me.

Scoring information. Begin by reverse scoring items # 8, 12, 14, 18, 20, and 24 by subtracting the item response from 8 and using the result as the item score for that item. Then calculate subscale scores by averaging the items scores for the items on each subscale. They are shown below. The (R) after an item number is just a reminder that the item score is the reverse of the participant’s response on that item.

Interest/enjoyment:
3, 5, 7, 11, 12(R), 15, 17, 23

Value/usefulness:
1, 4, 6, 10, 13, 16, 19, 21, 25

Perceived choice:
2, 8(R), 9, 14(R), 18(R), 20(R), 22, 24(R)
Appendix B: Compliance Log

Physical therapist home exercise plan directions (Completed by Therapist):
Example: Pt. should complete the 4 prescribed exercises 3x/week as indicated in diagram or video. Each exercise should be performed in 3 sets of 10 repetitions with 1 minute rest between sets.

Dates exercises were completed: __________________________ ex: 9/2/2012
Exercise 1: __________________________ ex: Mini Squats 3x10
Exercise 2: __________________________
Exercise 3: __________________________
Exercise 4: __________________________
Exercise 5: __________________________
Exercise 6: __________________________

If you did not complete any of the exercises, why not?
a. Too much pain
b. Fatigue
c. Forgot how to do the exercise
d. Ran out of time
e. Other: ____________________________________________

How confident did you feel that you were performing your exercises correctly?
a. Very confident, “I remember how to perform each exercise correctly”
b. Somewhat confident, “I remember how to do most of the exercises, but I am not always sure I am doing them correctly”
c. Not very confident, “I completed the exercises that I remembered but I was not sure I was following all of the instructions that my therapist provided”
d. Other: ____________________________________________

Please answer as honestly as possible. Please return this form in the attached sealed envelope to CHS 411 after one week.