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Motivational Regulation During Post-Stroke Rehabilitation:

The Role of Goal Adjustment

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by

Yongwon Cho

Thesis Committee:
Professor Jutta Heckhausen, Chair
Professor Steven C. Cramer
Assistant Professor Amy Dent

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ABSTRACT OF THE THESIS

Motivational Regulation During Post-Stroke Rehabilitation:

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By

Yongwon Cho

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Professor Jutta Heckhausen, Chair

We investigated motivational regulation involving goal adjustment processes in post-stroke rehabilitation under conditions of standard in-clinic physiotherapy and in-home gamified tele-rehabilitation (TR). Data were collected at 11 US sites in the context of a tele-rehabilitation clinical trial using video games and game control pads designed to induce certain arm movements required for recovery (n = 124; M_{age} = 61.44, SD =13.30). Participants were randomly assigned to either the TR or in-clinic condition and underwent 36 therapy sessions while reporting on their physical activity enjoyment for 6–8 weeks. Compared to the in-clinic patients, the TR patients reported lower activity-inherent motivation indicated by the level of enjoyment experienced. Results suggested this difference was due to TR patients becoming discouraged by low game score feedback, which may have signaled a poor prospect for recovery. However, those low game performers who also exhibited high goal adjustment capacity were resilient to the impact of low game score feedback on their motivation-related enjoyment. The

findings of the study suggest that goal adjustment capacity may be particularly important under conditions with limited motivational support.

CHAPTER 1: Introduction

Dealing with the loss of function after a stroke is extremely challenging, as patients often start with overly ambitious recovery goals and quickly become frustrated by what they perceive to be a lack of progress (Wiles, Ashburn, Payne, & Murphy, 2004). Such frustration may undermine their motivation to engage in therapy, resulting in less-than-optimal rehabilitation effectiveness. Therefore, it is important that patients have a realistic understanding of attainable recovery goals, and that they adjust their recovery goals to align with their actual rehabilitation progress. In this study, we explored motivational regulation processes in a clinical trial of post-stroke rehabilitation conducted through either an in-clinic (outpatient) therapy program or an in-home gamified tele-rehabilitation (TR) system (Cramer et al., 2019).

Many researchers have posited that the application of video-game-based therapy in rehabilitation programs might increase the level of enjoyment that patients experience (Lohse et al., 2013). However, in Cramer et al.'s (2019) study, the increase of activity-inherent enjoyment measured from the beginning to the end of therapy was unexpectedly lower among the gamified TR therapy group than among the in-clinic therapy group. Our current focus was to investigate the motivational challenges that TR therapy patients faced that may have affected their enjoyment level and motivational regulation strategies used in response to these challenges.

CHAPTER 2: Literature Review and Theoretical Context

Regulating motivation through goal adjustment

Research on goal pursuit over the last 50 years has shown that attaining difficult goals depends on investing substantial effort, persistence in the face of obstacles and setbacks, and remaining optimistic about one's efficacy and the attainability of the goal (Bandura, 1977; Carver et al., 1993; Freund & Baltes, 1998; Scheier et al., 1989; Seligman, Steen, Park, & Peterson, 2005). However, given that attaining a developmental goal is rarely a guaranteed outcome, it is critical to select realistic goals before investing extensive effort and time. To this end, a goal is not only selected based on desirability but on expectancy of goal attainment (Beckmann & H. Heckhausen, 2018). Engagement only makes sense if there are opportunities to pursue and achieve the goal—this holds for both short-term goals and longer-term developmental goals (see the congruence principle, J. Heckhausen, Wrosch, & Schulz, 2010).

When the selected goal is attainable, the most effective strategy would be to maintain strong engagement, strive for control over the outcome, and engage additional motivational strategies as needed to support goal striving. In contrast, a goal may become unattainable when resources needed for goal pursuit are lost due to an aversive event or are gradually depleted over time. In the case of lost control over the outcome, the optimal strategy is to abandon this goal and to adopt an alternative, more attainable one. Only by freeing up motivational and behavioral resources via disengaging from a futile goal can an individual productively engage with new attainable goals (see reviews in Barlow, Wrosch, & McGrath, 2019; Wrosch & Scheier, 2020). Thus, successful motivation regulation requires the ability to flexibly disengage from unattainable goals and reengage with new attainable goals. We explored this goal adjustment process in the context of changes during post-stroke rehabilitation over the course of six weeks.

Managing health-related goals

The general principle of motivational regulation discussed above applies to specific domains of life, such as health-related goals. Heckhausen, Wrosch, and Schulz's (2013) lines of defense model posits that certain types of health or functional goals become more or less adaptive depending on the state of a disease. It predicts appropriate motivational strategies for different levels of health status and functional rehabilitation—not just in terms of optimizing immediate outcomes, but also in terms of protecting motivational resources that ultimately lead to better long-term outcomes. When an individual is in a disease-free state and is not experiencing any functional loss, the health objective would be to maintain the status quo and build resilience to prevent future health declines. At this line of defense, a typical motivational strategy might be to maintain strong engagement with proactive health goals. However, once a given line of defense can no longer be held, the individual has to disengage from the goals of the previous line and engage with the new goals at the next line of defense. For example, when a sub-clinical disease surfaces, the goal should shift to minimizing disease progression. In this case, the previous goal of avoiding disease becomes obsolete and thus should be discarded in favor of the adjusted goal of preventing or slowing the disease progression and functional disability. This way, an individual can protect not only a sense of control but also his or her motivation to invest the required amount of effort into the new adjusted goal.

Effective motivational regulation depends on disengaging from unrealistic health goals at the previous line of defense and subsequently re-engaging with new goals is required. Especially in rehabilitation circumstances where the desired degree of recovery is often unattainable, goal adjustment strategies for letting go of an overly ambitious goal and reengaging with an adjusted more attainable goal could be helpful in protecting individuals from the aversive results of holding onto unachievable goals (Wrosch, Scheier, Miller, Schulz, & Carver, 2003b; von Blanckenburg, Seifart, Conrad, Exner, Rief, & Nestoriuc, 2014). Disengaging from an unrealistic recovery goal would prevent the waste of resources that could be invested in more feasible rehabilitation goals and the protective effect of goal adjustment strategies can be especially helpful in dealing with uncontrollable chronic conditions (J. Heckhausen et al., 2010; Hall, Chipperfield, J. Heckhausen, & Perry, 2010). Furthermore, individuals with good goal adjustment capacity have been found to have less frequent bouts of illness, be less likely to report depressive symptoms, report higher level of subjective well-being and higher satisfaction with physical health (Wrosch, Scheier, & Millet, 2013; Wrosch, Miller, Scheier, & Pontet, 2007; Dunne, Wrosch, & Miller, 2011).

This implies that an appropriate goal adjustment strategy for protecting motivation during difficult rehabilitation programs should involve relinquishing unattainable goals and selecting new and feasible goals. Thus, we examined how the application of goal adjustment strategy is associated with the patients' motivation for active participation in their rehabilitation activities.

Tele-rehabilitation clinical trial on arm function recovery

To explore the function of goal adjustment regarding the health-related motivational regulation process, we utilized an existing data set that Cramer et al. (2019) collected in their TR clinical trial. The trial systematically investigated the effect of a rehabilitation treatment devised for stroke patients who were attempting to regain their arm functionality. TR generally refers to a rehabilitation program that is conducted remotely from a traditional clinical site using telecommunication devices that are often installed in places that the patients can easily access (Rosen, 1999). Cramer et al. (2019) predicted that the TR therapy program they developed would overcome several drawbacks involved in conventional in-clinic therapy including access to therapists, difficulty with transportation, and patients' lack of enjoyment (Stewart & Cramer, 2013). Cramer et al. (2019) thus developed and administered a TR program via video game stations installed in patients' own homes. They equipped the stations with specially designed game controlling devices to induce certain arm movements required for recovery.

The results of their study broadly confirmed their hypotheses, showing that TR therapy was as effective as a matched dose of traditional in-clinic therapy in terms of recovery achieved (Cramer et al., 2019). However, the activity-inherent motivation they measured throughout the program showed that while enjoyment scores increased significantly in both the TR and in-clinic therapy groups, the rate of increase was lower among the TR patients (Cramer et al., 2019). Differences in activity-inherent motivation indicated by the level of enjoyment is a critical issue in a rehabilitation trial because it may positively predict recovery outcomes (Kendzierski & Morganstein, 2009). Thus, understanding the dynamics among the factors influencing activity-inherent motivation level is crucial for studying the effect of a rehabilitation program.

CHAPTER 3: The Present Study

The first objective of the current study was to explore possible reasons for the differences in activity-inherent motivation between the TR and in-clinic therapy groups as reported in Cramer et al. (2019). Specifically, we investigated how activity-inherent motivation indicated by the level of enjoyment experienced throughout the program differed between the TR and the in-clinic group and whether game performance feedback was associated with enjoyment. Study patients were provided with feedback on their game performance in numeric form, with the intent of increasing their awareness of how well they were executing the required arm motions. We predicted that TR patients who repeatedly received low game scores would experience less enjoyment based on the premise that they may become discouraged about attaining their recovery objectives. This prediction is consistent with another robot-aided rehabilitation study involving gamification with performance feedback, where the authors suggested that when the patients felt themselves to be less competent at rehabilitation tasks, their enjoyment and intrinsic motivation could be undermined (Colombo et al., 2007).

Moreover, for the group of patients who constantly received negative game feedback and were at risk of becoming discouraged, we expected that successfully adjusting their recovery goals would help sustain motivation. Patients who are unable to relinquish and adjust their potentially over-ambitious recovery goals are likely to deplete their motivational resources, become frustrated, and experience less enjoyment in the physical therapy. Thus, our second aim was to investigate whether the use of goal adjustment strategies was associated with the level of activity-inherent motivation especially among the patients who were susceptible to experience attenuated enjoyment from receiving low game score.

In the in-clinic therapy group, the therapists were responsible for goal assessment and facilitated the goal adjustment process instead of the patients. Therefore, in-clinic patients may have less need for goal adjustment capacities due to the external support they receive from therapists. This prediction is consistent with the idea that scaffolding by the social context alleviates the self-regulatory burden on the individual, especially under conditions of high challenge (J. Heckhausen & Wrosch, 2016). In contrast, the TR therapy group patients relatively had to rely more on their own goal adjustment capacities when responding to repeated challenges. Although TR patients interacted with the therapists with the same frequency as in-clinic patients did (i.e., three times a week), all interactions were conducted via video-conference and the duration of the interactions was significantly shorter than that of in-clinic patients. Unlike the in-clinic group Therefore, we explored whether goal adjustment helped the low-performing TR therapy patients sustain motivational recourses.

To summarize, being able to disengage from an unattainable goal can be essential in the process of rehabilitation after a stroke, as it allows patients to avoid wasting motivational, emotional, and behavioral resources on unrealistic goal pursuits and helps them to reengage with attainable goals. This could protect long-term motivational resources that support well-being (Hamm, J. Heckhausen, Shane, Infurna, & Lachman, 2019). Thus, we also predicted that patients who actively employed goal adjustment strategies would experience higher levels of satisfaction with the recovery outcome. In addition, we explored whether the benefit of goal adjustment on satisfaction for therapy was observed among low-performing TR patients specifically.

Based on these considerations, we investigated four hypotheses. First (H1), we predicted that the TR patients with low game performance would show less overall activity-inherent motivation level throughout the program compared to the patients with high game performance. Second (H2), we predicted that the TR patients' activity-inherent motivation throughout the program would be higher among the patients with greater use of goal adjustment strategies, as predicted from the previous literature about general benefit of goal adjustment. Third (H3), we expected that the consequences of goal adjustment for activity-inherent motivation will be pronounced among the patients with low game performance who are at-risk of becoming demotivated. In addition, (H4), we predicted that the TR patients who successfully protect their activity-inherent motivation through goal adjustment strategy will be more satisfied with the therapy. Lastly (H5), we expected that the TR patients who receive constant low game score feedback will be able to protect activity-inherent motivation through adjusting their goals, which would in turn facilitate higher levels of satisfaction with therapy.

CHAPTER 3: Method

Participants

124 stroke patients with arm motor deficits from 11 US sites participated in the clinical trial. 34 participants were female and 90 were male. The patients were 61.44 years old on average (*SD* = 13.30) and at the time of the study were 4–36 weeks post-stroke onset. The patients had mild to severe arm motor deficits and had no major deficits in mood or cognitive function. After being recruited, the patients signed an informed consent form and underwent baseline testing for the measures of interest. Aversive events related to therapy included arm/shoulder pain and muscle fatigue, which occurred in 6 members of the TR therapy group and 5 members of the in-clinic therapy group, but there was no resultant attrition.

Procedures

In both therapy groups, the rehabilitation exercises were designed based on an upper-extremity task-specific training manual (Lang & Birkenmeier, 2013) and an accelerated skill acquisition program (Winstein et al., 2016). Each session in both groups lasted for 70 minutes and involved standard therapy actions such as stretching, strengthening, and an active range of motion; these were achieved through 65 minutes/day of exercises and functional games. Patients also received 5 minutes of stroke education.

The in-clinic therapy group patients underwent 18 supervised sessions at the designated research centers as well as 18 unsupervised rehabilitation sessions in their homes over the course of 6 to 8 weeks. Licensed therapists provided the supervised sessions for a continuous 70 minutes; the patients used individualized booklets containing instructions for the unsupervised sessions. TR therapy group patients were provided with a TR station delivered and installed in their homes; all 36 sessions took place via the TR station. During the 18 supervised sessions, therapists had a 30-minute video-conference at the start of the session to guide the patients in choosing and playing the video games; they also helped the patients choose the right game controlling device and assigned the game difficulty level. After 30 minutes, the therapist disconnected from the video-conference, then the patient completed the remaining 35 minutes of therapy guided by the TR system. The patients conducted the 18 unsupervised sessions without any therapist contact; they chose the game, game controlling device, and game difficulty together with the therapists. The patients provided therapists feedback regarding the unsupervised sessions, and the therapists adjusted the choices of game and device based on the feedback. Thus, TR patients influenced the choice of game, controlling device, and game difficulty.

Measurements

Baseline assessments were conducted for each patient during their initial visit to the research center after recruitment. At the end of the first and the sixth week of therapy, assessments were conducted at the end of the sessions in both therapy groups. In addition, immediately after the end of therapy and again at 30-days post-therapy, follow-up measurements of arm motor recovery were collected during return visits to the research center.

Goal Adjustment. Goal adjustment level was measured using the Optimization in Primary and Secondary Control (OPS) scale (J. Heckhausen, Schulz, & Wrosch, 1998). The scale consisted of 12 goal management-related items that were rated on a seven-point Likert scale (1 = *Strongly Disagree*, 7 = *Strongly Agree*). Among the four sub-scales (i.e., goal engagement, goal disengagement, goal reengagement, and self-protection), we combined goal disengagement and goal reengagement items as indicators of goal adjustment level, as conceptualized by Wrosch and colleagues (2003). OPS items were answered with respect to participants' recovery goals. The OPS-scale was administered at baseline (*M* = 15.08. *SD* = 4.85) at the end of the first week (*M* = 16.09, *SD* = 4.87) and at the end of the sixth week (*M* = 16.13*, SD* = 3.95). Changes in the use of goal adjustment strategies in response to initial challenges was calculated by subtracting baseline goal adjustment from goal adjustment measured after the first week of therapy. The variable was labeled *ΔGoal Adjustment*.

Activity-Inherent Motivation. The Physical Activity Enjoyment Scale (PACES) was given, including eight items with seven-point Likert scales. The items measured activity-inherent enjoyment reflecting how much the patients enjoyed their required activities (Kendzierski & Morganstein, 2009). The PACES level was assessed at baseline (*M* = 37.76, *SD* = 11.05), and follow-up assessments were conducted at the end of the first (*M* = 43.36, *SD* = 9.39) and sixth weeks (*M* = 44.59, *SD* = 8.81). The level of activity-inherent motivation was averaged across weeks and labeled $PACES_{average}$ to capture an overall indicator of activity-inherent motivation.

Game Performance Assessment. We calculated the patients' game performance scores based on the highest scores the patients reached. Different weightings were given in accordance with the game difficulty chosen in each session as per convention in game performance data analysis (Cheng, She, & Annetta, 2015). Because all 25 available video games had different scoring increments, and because not all games were played by all patients, a comprehensive analysis that collapsed all score data into one continuous measurement of game performance was not possible. Instead, we chose to focus our analyses on the game played by all patients, namely "Flappy Bird." The average score for "Flappy Bird" was 40.88 (*SD* = 26.78). Consistent with previous research (Ventura & Shute, 2013; Harwell, Boot, & Ericsson, 2018; Wu et al., 2012), we dichotomized (i.e., top half versus bottom half) the TR therapy group patients into high performers (*M* = 61.92, *SD* = 20.13) and low performers (*M* = 19.00, *SD* = 9.65).

Fugl-Meyer Assessment. Arm motor status was assessed with the Fugl-Meyer test, which consists of 33 items that asses various aspects of arm movement, each item scored on a 3-point ordinal scale (0 = *item could not be performed at all*; 1 = *partial performance*; 2 = *perfect performance*) (See et al., 2013). The assessment was conducted at the recruitment screening process (*M* = 41.85, *SD* = 8.69), at baseline (*M* = 42.76, *SD* = 8.26), at the live visit immediately following end of therapy (*M* = 49.62, *SD* = 8.93), and 30 days after the end of the therapy (*M* = 50.25, *SD* = 9.96). For the indicator of arm motor status recovery achieved from therapy, the baseline Fugl-Meyer score assessed at the beginning of the therapy was subtracted from the Fugl-Meyer score assessed at the end of the therapy, and was labeled *ΔFugl-Meyer*.

Patient Satisfaction. Patient satisfaction level was assessed at the first (*M* = 54.62, *SD* = 8.34) and final session of the therapy (*M* = 56.33, *SD* = 9.59) using a seven-point Likert scale with 10 items related to the patients' satisfaction on therapy program and required exercises (1 = *Not satisfied at all*, 7 = *Very satisfied*). We used the final session measure as the indicator of overall satisfaction for the therapy.

Covariates. Given previous findings of patients' age and gender being associated with motivational regulation in rehabilitation processes (Reuter et al., 2010; Leung, Grewal, Stewart, & Grace, 2008), age (*M* = 61.44, *SD* = 13.30) and gender (72.58% male) were included as covariates in all models.

CHAPTER 5: Results

Preliminary analysis

We conducted a preliminary analysis to examine the distribution of each variable of interest. Table 1 shows the patients' sample statistics for the variables of interest for both the in-clinic therapy patients and the TR therapy patients. All variables of interest showed acceptable levels of variance and comparatively balanced distributions.

Bivariate correlations and descriptive statistics between ΔGoal Adjustment, $PACES_{average}$, ΔFugl-Meyer, patient satisfaction, and game performance among TR patients are shown in Table 2 (N = 57). ΔGoal Adjustment was positively associated with $PACES_{average}$ (r = .40, p = .002), and greater patient satisfaction (r = .30, p = .025). $PACES_{average}$ was associated with greater patient satisfaction (r = .59, p < .001), and higher game performance level (r = .31, p = .021). However, ΔFugl-Meyer did not show any significant associations with other variables.

Table 1

Sample Statistics of Variables, Separated by Treatment Group

Treatment				Skewedness		Kurtosis	
Variables	*n*	*M*	*SD*	Test Statistic	*SE*	Test Statistic	*SE*
In-clinic							
Goal Engagement (Baseline)	59	23.52	3.96	-.60	.31	-.44	.61
PACES (Baseline)	61	37.08	10.71	-.33	.31	.03	.60
PACES (Week 1)	59	44.36	9.16	-.56	.31	-.27	.61
PACES (Week 6)	56	46.20	7.87	-.67	.32	.22	.63
Fugl-Meyer (Baseline)	62	42.68	8.73	-.38	.30	-1.1	.60
Fugl-Meyer (Post)	60	49.72	9.35	-.58	.31	-.33	.61
Tele-Rehab							
Goal Engagement (Baseline)	62	24.18	3.86	-1.12	.30	1.12	.60
Goal Adjustment (Baseline)	60	15.38	5.042	-.13	.31	.49	.61
Goal Adjustment (Week 1)	58	16.59	4.53	.84	.31	.75	.62
PACES (Baseline)	60	38.47	11.42	-.30	.31	-.46	.61
PACES (Week 1)	58	42.34	9.59	-.08	.31	-.79	.62
PACES (Week 6)	58	43.03	9.45	-.18	.31	-1.12	.62
Fugl-Meyer (Baseline)	62	42.84	7.84	-.24	.30	-.23	.60
Fugl-Meyer (Post)	62	49.53	8.58	-.51	.30	.01	.60
Patient Satisfaction (Week 6)	59	54.25	10.50	-.98	.31	11.19	.61

Note. n, *M*, *SD*, and *SE* represent number, mean, standard deviation, and standard error, respectively.

Table 2

Correlation Matrix for Variables of Interest, within TR Group

Variable	1	2	3	4	5	6	7	*M*	*SD*
1. ΔGoal Adjustment	-							1.09	5.74
2. $PACES_{average}$	.399**	-						41.36	8.68
3. ΔFugl-Meyer	.035	-.038	-					6.69	6.10
4. Patient Satisfaction	.296*	.593**	.142	-				54.25	10.50
5. Game Score	.082	.306*	-.067	.238	-			1.09	5.74
6. Age	-.04	.11	-.02	.02	-.03	-		62.44	13.65
7. Gender	-.19	-.06	.15	-.21	-.08	-.04	-	1.23	.42

Note. Game score was dichotomized variable (0 = lower end, 1 = higher end). *M* and *SD* represent mean and standard deviation, respectively. * $p < .05$, ** $p < .01$.

Game performance feedback and activity-inherent motivation (PACES)

We conducted an analysis of variance (ANCOVA) to test differences in $PACES_{average}$ between the in-clinic and TR groups, controlling for age and gender. We note that the in-clinic patient group did not have a game performance-related measure because they were not exposed to the games, which meant we were unable to test a 2 (in-clinic, TR) x 2 (low, high) treatment group by performance level interaction. As an alternative, a one-way ANCOVA was conducted using three groups of interest (in-clinic, TR high performers, TR low performers) as the categorical independent variable, and continuous score of $PACES_{average}$ as the dependent variable. The ANCOVA results showed that $PACES_{average}$ differed by group ($F(2,108) = 6.71$, $p = .011$, see Figure 1).

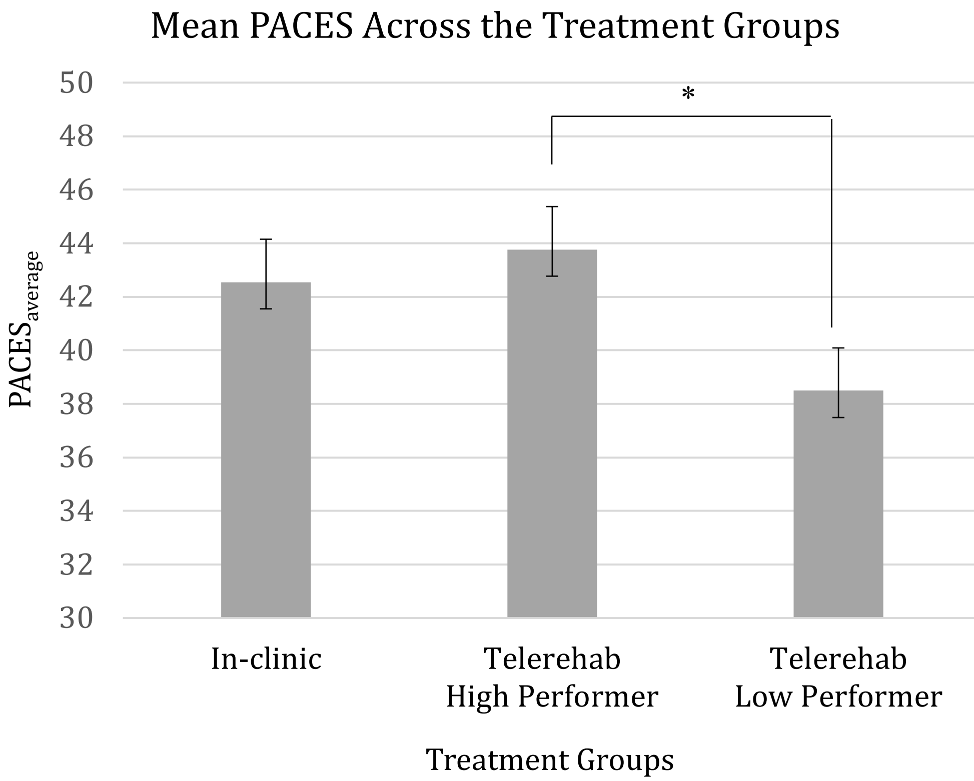

Figure 1. *Figure 1*. Error bars represent standard errors. * $p < .05$.

Post hoc comparisons using the Scheffe's procedure indicated that the mean score of $PACES_{average}$ among TR low performers (M = 38.49, SD = 5.96) was significantly lower than TR high performers (M = 43.77, SD = 9.89) ($t(25) = 2.62$, p = .012, d = .63). However, $PACES_{average}$ did not significantly differ between TR high performers and in-clinic patients (M = 42.55, SD = 6.72) ($t(25) = .71$, p = .422, d = .15). In other words, the TR low performers in particular might have struggled to maintain their enjoyment of the physical therapy activities compared to the other groups because they were constantly receiving negative feedback on their game performance. This finding supports the first hypothesis (H1) and provides context for the unexpected result from the original study showing lower PACES scores among TR patients (Cramer et al., 2019).

Motivational benefits of goal adjustment strategies

To address the second hypothesis (H2) and examine the general benefit of employing goal adjustment strategies for all TR patients, linear regression modeling was conducted using ΔGoal Adjustment as the predictor variable and $\text{PACES}_{\text{average}}$ as the outcome variable, controlling for age and gender. The regression model accounted for 18% of the variances in $\text{PACES}_{\text{average}}$ ($F(3, 53) = 3.78$, $p = .016$). Among TR patients, ΔGoal Adjustment predicted higher level of $\text{PACES}_{\text{average}}$ ($\beta = .41$, $p = .002$). The result is consistent with H2 and suggest that patients who increased their use of goal adjustment strategies were better able to protect their motivational resources (i.e., enjoyment of physical therapy activity).

Goal adjustment for low performers in the TR group

Separate regression analyses were conducted for high performers and low performers in the TR group to test H3. This permitted us to examine whether changes in goal adjustment protected motivation for TR patients with low game scores who were at-risk of becoming demotivated. For each performance group, we regressed $\text{PACES}_{\text{average}}$ on ΔGoal Adjustment (see Table 3).

Table 3

Linear Regression Models, using PACESaverage as Outcome Variable, within TR Group

Variables	*b*	*SE*	*β*	*t*	*p*
High Performers					
(constant)	33.74	11.87		2.84	. 008
ΔGoal Adjustment	.61	.60	.20	1.01	.320
Age	.10	.14	.14	.72	.476
Gender	1.9	4.82	.08	.41	.685
		F (3, 27) = .46, p = .715, R^2 = .048			
Low Performers					
(constant)	40.29	5.80		6.95	<. 001
ΔGoal Adjustment	.78	.20	.62	3.82	.001
Age	.03	.08	.06	.35	.727
Gender	-2.71	2.58	-.17	-1.05	.304
		F (3, 22) = 5.58, p = .005, R^2 = .432			

Note. b, *SE*, *β*, *t*, and *p* respectively indicate unstandardized coefficient, standard error, standardized coefficient, t statistics, and probability statistics.

Supporting H3, ΔGoal Adjustment positively predicted $PACES_{average}$ among the low performers (β =.62, p = .001), but not among the high performers (β = .20, p = .320) (see Figure 2). This pattern illustrates that low-performing TR patients who adjusted their goals were better able to protect their motivation in the face of poor game score feedback. In other words, this finding indicates that active goal adjustment enabled TR patients to maintain their therapy-related motivation despite negative game performance feedback.

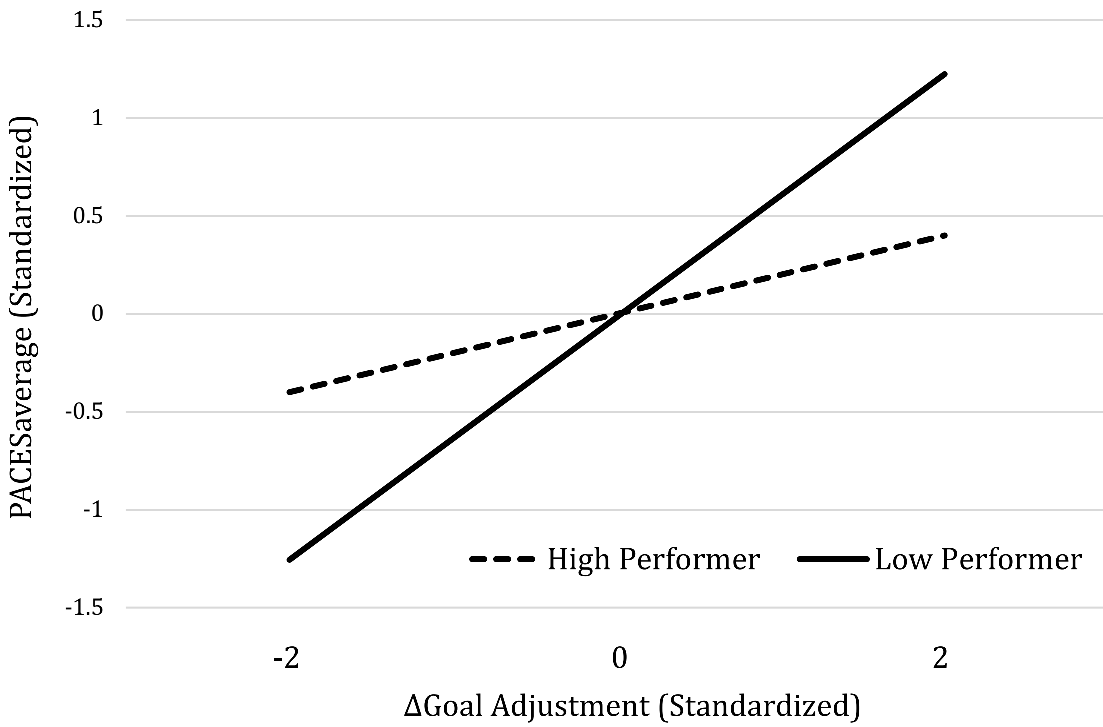

Figure 2. Relationships between ΔGoal Adjustment and PACES in high-performing TR patients and low-performing TR patients are depict. Age and gender were controlled in the model.

Motivational regulation and patient satisfaction for TR therapy

H4 was tested using a series of regression models that assessed whether the relationship between ΔGoal Adjustment and patient satisfaction was mediated by $\text{PACES}_{\text{average}}$ in the TR group (Baron & Kenny, 1986; Hayes, 2017). First, we regressed the mediator on the focal predictor and found that ΔGoal Adjustment significantly predicted $\text{PACES}_{\text{average}}$ ($\beta = .41$, $p = .002$). Second, we regressed the outcome on the mediator and found that higher level of $\text{PACES}_{\text{average}}$ predicted increased satisfaction with the therapy exercises ($\beta = .57$, $p < .001$). Third, we conducted a formal test of mediation by assessing the indirect effect of our focal predictor (ΔGoal Adjustment) on the outcome (satisfaction) via the mediator ($\text{PACES}_{\text{average}}$) (Hayes, 2017). The standardized indirect effect from ΔGoal

Adjustment to patient satisfaction via $PACES_{average}$ was .23. This effect was tested for significance using a bootstrap approach that employed 95% bias corrected confidence intervals based on 5,000 samples of the indirect effect. Results showed that 95% confidence interval did not contain zero (CIs = .09 to .40), which indicated that the indirect effect was significant (Hayes, 2017). ΔGoal Adjustment did not predict patient satisfaction (β = .09, p = .611) when controlling $PACES_{average}$, implying that the relationship was fully mediated. However, patient satisfaction was not significantly correlated with ΔFugl-Meyer (r = .14, p = .285).

The same pattern of mediation was observed to be significant among only the low performers, supporting H5 (see Figure 3). First, the focal predictor (ΔGoal Adjustment) significantly predicted the mediator ($PACES_{average}$) (β = .62, p = .001). Second, the mediator ($PACES_{average}$) significantly predicted the outcome variable (patient satisfaction at the end of therapy) (β = .61, p = .001). Third, to conduct a formal test of mediation, we assessed the indirect effect of ΔGoal Adjustment on the patient satisfaction via the mediator $PACES_{average}$. The standardized indirect effect was .38, and its significance was tested based on bootstrapping procedures. Standardized indirect effects were computed for each of 5,000 bootstrapped samples, and the 95% confidence interval was computed. The 95% confidence interval did not contain zero (CIs = .13 to .64), indicating that the indirect effect was statistically significant (Hayes, 2017). When $PACES_{average}$ was controlled, ΔGoal Adjustment was not significantly associated with patient satisfaction (β = .39, p = .055), indicating the relationship was fully mediated.

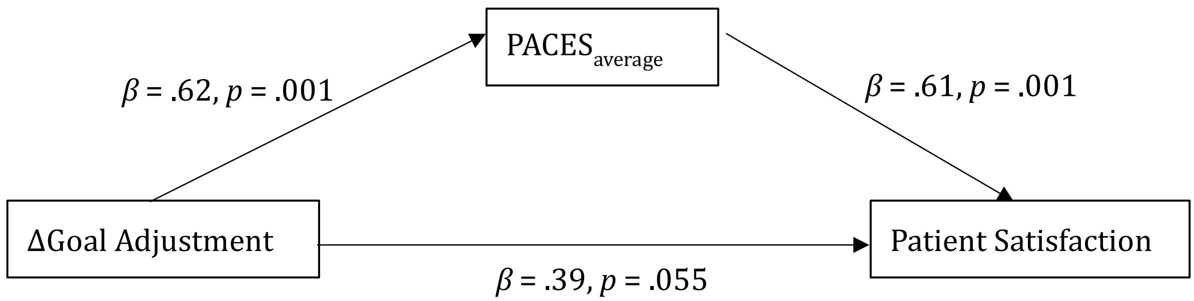

Figure 3. Within the low-performing group, the mediation model showed that activity-inherent motivation ($PACES_{average}$) mediated the relation between the application of goal adjustment strategy (ΔGoal Adjustment) and patient satisfaction, with a significant indirect effect (β = .38, 95% CI [.13, .64]). Age and gender were controlled as covariates.

CHAPTER 6: Discussion

The present study sought to shed light on the role of goal adjustment processes during post-stroke rehabilitation when the attainment of the original recovery goal was uncertain. We predicted that increased use of goal adjustment strategies would reflect an adaptive response to challenges encountered during the TR program. Our findings suggest that the TR therapy patients struggled to sustain their motivation when they received negative game score feedback. Results suggested greater application of goal adjustment strategy may serve a protective function in supporting patients' motivation when facing such challenges.

The demotivating consequences of low game score feedback

The analysis on the difference of activity-inherent motivation by game score feedback supported the first hypothesis (H1). Findings indicated that the overall level of activity-inherent motivation across the therapy was significantly lower among TR low performers, when compared to TR high performers and the in-clinic therapy patients. This may explain why the TR patients showed lower PACES scores when compared to the in-clinic patients in the original study (Cramer et al., 2019). Repeated exposure to negative feedback on their game performance may have undermined motivation among low performers. More specifically, it is possible that the negative feedback they experienced signaled that their original goals might not be attainable, resulting in disappointment and less enjoyment.

Goal adjustment and motivational regulation

In regard to the second hypothesis (H2), the regression model indicated that the patients who used goal adjustment strategies to a greater extent were able to protect their motivational resources for therapy exercises. This is consistent with previous studies describing general benefits experienced among the people with high goal adjustment capacity (Wrosch et al, 2013). For TR patients, goal adjustment presumably enabled them to shift their effort towards attainable goals rather than having to give up on their rehabilitation goals altogether.

Consistent with the third hypothesis (H3), we found that increases in goal adjustment predicted a higher PACES predominantly among the low performers (see Table 3). This may indicate that goal adjustment strategy was typically helpful in maintaining enjoyment when the patients were receiving low game score. After receiving implicit feedback on their rehabilitation progress, patients who actively applied goal adjustment strategies might have successfully let go of their initial goals, protecting their motivation from disappointment.

This finding is consistent with several studies on situations where letting go of an unattainable health goal can lead to improved motivational regulation (Wrosch et al., 2007; Wrosch et al., 2013). Our finding is in line with these studies when reflecting upon the analysis of goal adjustment process. In contrast, those patients who applied goal adjustment strategy to a lesser degree might have continued to pursue futile, overly ambitious recovery goals. This interpretation converges with a previous review on aversive consequences of engaging with an unattainable goal (Carver & Scheier, 1990).

In addition, it is interesting that goal adjustment did not predict the PACES scores among the high performers. Having a high game score might have indicated to those patients that the original goal was still attainable; therefore, the high performers did not have to abandon it.

Benefit of goal adjustment on patient satisfaction

Consistent with our mediation hypothesis (H4), we found that the motivational benefits of increased goal adjustment translated into greater satisfaction at the end of therapy. Increased use of goal adjustment strategies resulted in patients being more satisfied with the therapy at the end of the rehabilitation program, via the change in activity-inherent motivation. It is notable that the patient satisfaction level was not related to the actual level of arm motor status recovery achieved. This suggests that, even when the recovery outcome was not ideal, patients who maintained high levels of activity-inherent motivation were content with their therapy. Simultaneously, it may imply as well that if a patient lacks goal adjustment capacity and fails to manage the rehabilitation goal according to discouraging feedback, the patient might leave the therapy unsatisfied independently from recovery outcome.

Supporting H5, low performers who increased their use of goal adjustment strategies experienced greater satisfaction with therapy as a function of their higher activity-inherent motivation, regardless of the amount of arm motor status recovery achieved. Despite the negative prospective informed by the low game score feedback, if the patients were able to lower their recovery goal accordingly to it and protect motivation for the therapy, they found the rehabilitation program to be satisfactory.

Limitations and future research

One limitation of the present study is that we did not explicitly measure the actual level of the initial or adjusted recovery goal. Furthermore, decline in arm motor status itself represents a broad spectrum of symptoms that are not easily summarized in a single scale; thus, the type of arm recovery each patient desired might have qualitatively varied. In this regard, future researchers should utilize more detailed and multi-faceted performance standards to track patients' actual adoption and adjustment of their goals.

Another limitation concerns the fact that participants in the current study had very high motivation levels from the beginning of the therapy. The clinical trial being a volunteer study, had to rely on patients' continued participation and high motivation. The patients were recruited as volunteers to an experimental trial, and the recruiting process might have attracted people with high anticipation and motivation in terms of their recovery. In other words, the goal adjustment process observed in the current study only applies to stroke rehabilitation patients with strong motivation for recovery. In future work, recruiting patients with a broader range of baseline motivation levels will make the findings more generalizable. In terms of the clinical consequences, it will also provide an opportunity to measure how the video game activity in a rehabilitation process may increase motivation that started out at a lower level.

Conclusion

Our results show the importance of maintaining activity-inherent motivation in a rehabilitation program and the benefit of goal adjustment strategy in achieving it. In the process of rehabilitation after the loss of certain physical function, patients often have to face the difficult reality that their initial anticipated level of recovery may not be attainable (Wiles, Ashburn, Payne, & Murphy, 2004). However, our results suggest that patients were able to sustain their activity-inherent motivation when goal adjustment strategies were used in response to setbacks. Moreover, when their enjoyment level was maintained by the goal adjustment process, it facilitated satisfaction with therapy regardless of actual improvements in arm motor status. Thus, when designing tele-rehabilitation therapy, incorporating a system that can assist patients with motivational regulation, should be considered. Our findings may have clinical implications as well. In rehabilitation programs using video games, it is a standard practice to adopt a game score feedback system (Lange, Flynn, & Rizzo, 2009; Johansson & Wild, 2011). Although it might be informative for the patients, it also could be seriously discouraging for them, especially when they have poor game performance and fail to adjust their goals. In this respect, the current study may describe the profile of the potential risk group in this type of therapy program.

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