

UNIVERSITY OF TWENTE.

December the 16th of 2011

-Roessingh Research and Development- Measuring the Bio-Feedback of Patients During Their Physical Activity

Investigating the Difference between Objective and Subjective Activity Level

By Eva-Maria Möller

s0167312

Mentors: Stans C.H.C. Drossaert, PhD and
Richard M.H. Evering, MSc

Abstract

Existing research about patients with chronic fatigue syndrome (CFS) suggests that physical activity plays an important role in the progress and maintenance of the disease. The aim of the present study was to further investigate the influence of objective physical activity on CFS patients. To gain better insights into the factors influencing physical activity patients have been examined according to the accuracy of their estimates about their physical activity and their fatigue level. During the experiment 23 participants were provided with an ambulant feedback system. This feedback was either based on the average behavior of healthy people or on one's own average physical activity. The patient's objective activity level was measured by a tri-axial piezoelectric accelerometer. Their subjective activity and fatigue level were measured by self-reported scores. In the course of the experiment an increased positive correlation between objective- and subjective activity level was found. During the first week, the baseline level (without feedback) was measured, which revealed significantly a moderate negative correlation between objective activity level and fatigue. No significant differences have been found between the two feedback comparison groups. Consequently, CFS patients do accurately estimate their physical activity. The two feedback groups had no different influence on the patients regarding subjective and objective activity and fatigue. Overall, participants felt more tired as their physical activity level increased.

Introduction:

What is chronic fatigue syndrome? - A Definition

It is to say that no general definition of Chronic Fatigue Syndrome (CFS) exists. Although there is a lack of standardized reproducible diagnostic criteria for CFS, some criteria can be found in most definitions. Besides, the fact that CFS is “clinically evaluated, unexplained, persistent or relapsing chronic fatigue” (Fukuda, Straus, Hickie, Sharpe, Dobbins, & Komaroff, 1994), most researchers agree that CFS means that people experience a reduction in daily activity over at least six month (Heyll, Wachauf, & Diewitz, 1997; Reeves, Wagner, Nisenbaum, & Jones, 2005; Fukuda, Straus, Hickie, Sharpe, Dobbins, & Komaroff, 1994). CFS is not only confined to fatigue. Syndromes like impaired memory or concentration, headaches, joint pain and unusual post exertional fatigue are associated with CFS as well (Holmes, et al., 1988; Fukuda, Straus, Hickie, Sharpe, Dobbins, & Komaroff, 1994). The definition capturing all of the above mentioned factors will be used throughout this article: „CFS is defined as persistent or relapsing fatigue of at least 6-months' duration, that is not alleviated by rest, and that causes substantial reduction in activities. The fatigue cannot be explained by medical or psychiatric conditions and must be accompanied by at least 4 of 8 case defining symptoms (unusual post exertional fatigue, impaired memory or concentration, unrefreshing sleep, headaches, muscle pain, joint pain, sore throat and tender cervical nodes)“ (Fukuda, Straus, Hickie, Sharpe, Dobbins, & Komaroff, 1994).

General background information

The prevalence numbers concerning the people affected by chronic fatigue syndrome have been found between the range of 7 to 267 cases per 100,000 persons in one study (Komaroff, et al., 1996) and 4 to 2.600 cases per 100.000 persons in another study (Jason, et al., 1997). Possible explanations of the wide diversity between different studies might be the use of different definitions within the studies and the large different in sample sizes. In general, the prevalence of CFS is substantially higher among women than men (Jason, et al., 1999; Lindal, Stefansson, & Bergmann, 2002, Buchwald, Pearlman, Kith, & Schmalings, 1994). Bailey (2010) found an occurrence four times more frequently in women comparing to men. Research has

shown that individuals between the age of 40 and 50 seem to exhibit the highest rates of CFS (Jason, et al., 1999; Bailey, 2010). However, as epidemiological studies are lacking, it is not possible to make any comparisons within this age group (Garrakla & Rangel, 2001; Marshall, 1999). Whereas comparing the socioeconomic status has revealed that the SES of people affected “the prevalence of CFS was highest among skilled workers and lowest among professionals” (Jason, et al., 1999).

Key symptoms of CFS: physical movement and fatigue

Among CFS patients, a difference can be made between those who are rated according to their activity level and compared with healthy people and those rated according to a difference in their experienced fatigue. The patients’ fatigue level is higher in comparison to healthy people. They are burdened with severe disabling fatigue. People suffering from CFS often have to quit their jobs as their tiredness makes it unable for them to work. Therefore, CFS can have a large impact on the patients’ lives. Sometimes, physical movement of the patients, is disordered, which leads to a deterioration of health status. Black, O’Connor and McCully (2005) found a reduction of movement up to 40% by CFS patients compared with healthy people. To explain the influence of physical movement, Wessley and colleagues developed a model which explains the impact of the patients’ illness related false beliefs on about their health status. The patients are in, what Wessley et al. (1999) called the “negative vicious circle”. The circle starts with an acute illness, often paired with inactivity resulting in a decreased fitness level. When CFS patients start to increase their physical movement again, they often experience an aggravation of the syndromes such as “myalgia, headache, sore throat, gastrointestinal complaints, and memory and concentration problems” (Wessely, Nimnuan, & Sharpe, 1999). Consequently patients reduce their physical activity again, which leads the symptoms not only to occur at a higher level but also at a lower level of physical activity (Vercoulen, et al., 1997). However, low activity levels can lead to an increased risk for several diseases, for example cardiovascular disease (Thompson, et al., 2003) and Type II diabetes (Hu, et al., 1999). Therefore, the patients have difficulties when they try to break out the circle through fulfilling both aims: preventing the symptoms and keeping their physical movement at a moderate level.

Since physical activity and fatigue are the key factors within CFS, researchers examine the relation between these variables in order to get new insights about the disease. On the one hand, researchers found comparable or even higher physical activity by CFS patients compared with healthy controls (Vanness, Snell, Strayer, Dempsey, & Stevens, 2003; Werf, J.B. Prins, Meer, & Bleijenberg, 2000). However, other researchers found that the negative influence of CFS in patients can be reduced by increasing daily activity (Black, O'Connor, & McCully, 2005; Fulcher, 1997; Wearden, et al., 1998; Powell, Bentall, Nye, & Edwards, 2004). They found that fatigue is linked with a low physical activity (Clearing-Sky, 1988; Dubbert, 1992), which means that people are feeling more tired when they are moving just a little. On the basis of these findings Fulcher (1997) conducted further research and discovered that “total and physical fatigue [...] and general health were significantly better after exercise than after flexibility treatment” (Fulcher, 1997). An overview can be found in Appendix 1. Since the relation between physical activity level and fatigue is still in its infancy further research is necessary. The question, leading this research is: Are physical activity and fatigue connected with each other and, if a connection will be found, how does it look like?

The role of self-assessment

To examine the relation between factors crucial for a better understanding of CFS one has to include the patient's self-assessment, which will form the basis for an effective treatment. The first steps in helping patients to feel better, is to change their activity pattern. It is widely known, that a treatment is needed where patients get the opportunity to experience their mistakes. Therefore, the role of self-assessment is crucial.

The self-assessment of physical activity level is a subjective variable, which differs for each individual as the interpretations are personal (Weering, Vollenbroek-Hutten, & Kotte, 2007). Thus, it can be seen as a person's estimation of his or her objective physical activity. Weering, Vollenbroek-Hutten and Kotte (2007) found that the self-assessment of physical activity of CFS patients was lower than the actual physical activity. Being more precisely “subjective outcome assessments resulted more often (92%) in statistical significant lower physical activity levels in patients with chronic fatigue syndrome, as compared to objective outcome assessments (70%)“ (Evering, Weering, Groothuis-Oudshoorn, & Vollenbroek-Hutten,

2011). This implies that most of the time CFS patients underestimate their physical activity. A wrong self-assessment of physical activity means implicates that CFS patients are unable to make realistic estimations of their physical activity. Furthermore, studies have shown that a negative self-assessment of one's physical activity, can lead to a malfunctioning physical activity pattern (Evering, Weering, Groothuis-Oudshoorn, & Vollenbroek-Hutten, 2011; Fry & Martin, 1996). So it is important to examine to what extent the patients' self-assessment of physical activity matches their objective physical activity.

As pointed out before, self-assessment is a crucial factor concerning physical activity, which is important for the CFS patients, since one of the symptoms is a disturbed physical activity. As mentioned before, another crucial factor is fatigue. To get a better overall picture and an effective treatment, the relation between fatigue and self-assessment should also be taken into account. Researchers found that “those patients in the exercise group who rated themselves as better had no significantly greater improvement in either peak oxygen consumption” (Silver, Haeney, Vijayadurai, Wilks, Patrick, & Main, 2001). Interpreting the results one comes to the conclusion that the feeling of being more active is already enough to feel less fatigue. Actually Silver et. al (2001) goes one step further by stating that the belief in an improved physical activity, thus a high estimation of physical activity level, is even more important to feel better than the objective activity level. To test this hypothesis it is important to do further researcher regarding the relationship between self-assessment of physical activity and fatigue.

The role of feedback

As pointed out before, self-assessment seems to be an important factor for fatigue and physical activity level. This means that when self-assessment of the physical activity level is increased, CFS patients consequentially will feel themselves better. One way of improving people's self-assessment is by giving feedback. With the help of an external advice, people can learn to make the right estimations by creating associations between the feedback and their own behavior. Today's technology makes it possible to give people feedback in form of an ambulant apparatus. Through this invention patients can receive feedback in their daily lives. In the context of CFS it can be examined in how far this ambulant feedback has an influence on the crucial factors. More concrete, does the use of regular ambulant feedback increase objective physical

activity or reduce fatigue? In how far can feedback influence the relation between self-assessment and physical activity?

Giving feedback implies that a person's behavior is compared to some other behavior. However the question remains, which behavior should be used as a comparison? Two alternatives are possible. First, the comparison can be based on the behaviors of others, since the behavior of other people defines the average behavior; this type is called *social comparison*. Second, the comparison can be based on one's own behavior. Here, the recent behavior forms the basis of average to compare with the present behavior, which is called *temporal comparison*. Concerning the CFS patients it is interesting to examine if it makes a difference which comparison style is used regarding regular ambulant feedback.

Scope of research and research questions

The literature research pointed out that self-assessment, objective physical activity and fatigue plays an important role in CFS. Some studies show that people often underestimate their own physical activity level. Since the connection between the two factors is quite unclear so far, this study has the aim to gain additional insights into how CFS patient are aware of their own physical activity level. Moreover fatigue, as the name of the syndrome implies, has a huge impact on the patients' lives. The literature shows contrary results regarding the relationship between fatigue and physical activity. Some researchers found a positive and some a negative correlation between the two factors. This is why further research in this field is necessary. Concerning self-assessment and fatigue little research has been done. Silver et. al (2001) suggests that feeling more physical active is already enough to feel less fatigue. Further researcher has to be done more precisely concerning the relation between the two factors. Since the technology makes it possible to give ambulant regular feedback it is additionally interesting to examine in how far this has an influence of the factors. As feedback can be very different it is also interesting to examine in how far differences in the results can be detected while using different comparison groups.

Conclusively, the research questions of this paper are formulated as follows:

1. *To what extent do patients make realistic estimations of their activity level?*
2. *What is the relation between activity level (subjective & objective) and fatigue level?*
3. *Does regular ambulant feedback help to*
 - 3.1. *make more accurate estimation of one's physical activity level?*
 - 3.2. *increase objective physical activity?*
 - 3.3. *reduce fatigue?*
4. *Regarding the above question what is the difference between temporal and social comparison feedback?*

Methods

To find answers on the research questions an experimental study was conducted.

Participants

The participants were recruited from the Roessingh Rehabilitation Center in Enschede, Netherlands, as well as by advertising in a local newspaper article handing out in the Eastern part of the Netherlands. A total of 23 participants (18 female, 5 male) between 18 and 56 (mean age = 34) took part in the present study. Precondition for participating was the presence of chronic fatigue syndrome diagnosed by a general practitioner or a physician according to the criteria for CFS of the Centers of Disease Control and Prevention of 1994, defined in the introduction (Fukuda, Straus, Hickie, Sharpe, Dobbins, & Komaroff, 1994). Other inclusion criteria were: fatigue as the primary complaint, aged between 18 and 65 years, no structural pathology explaining the fatigue complaints, not yet in treatment with clinical intake, not bounded to a wheelchair, not being pregnant.

Study design and outcome measures

The experiment consisted of three different stages: the baseline measurement and two feedback phases (Figure 1). During the intake all participants were instructed about the measurement procedure.

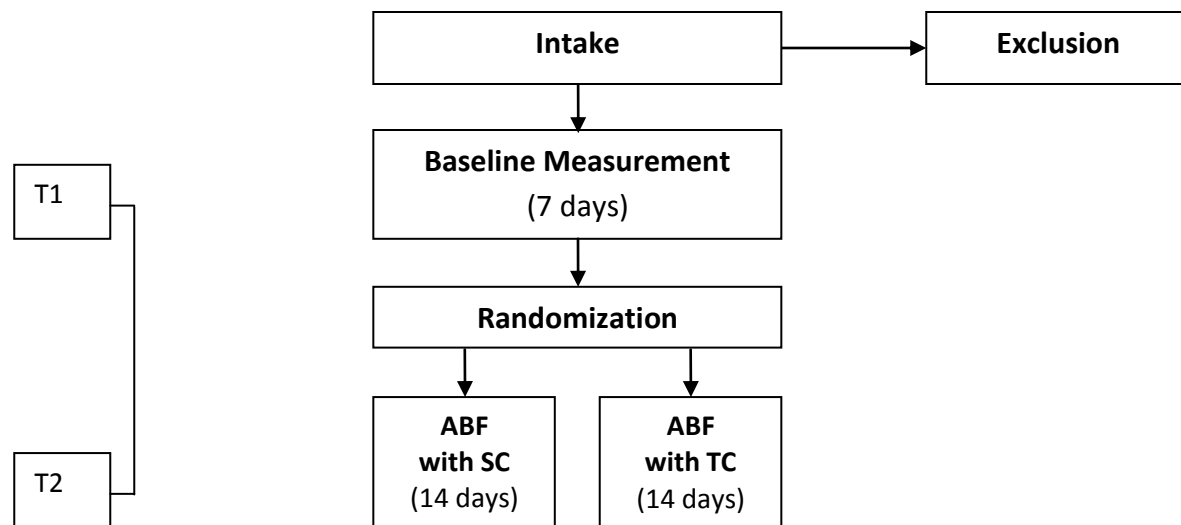


Figure1 Overview of the research design

The baseline measurement took 7 days. Afterwards the participants got randomized into two groups. One group got a norm-line based on a healthy control group (social comparison) and the other one got a norm-line based on the mean of the individual baseline measurement and the healthy control group (temporal comparison). The participants were told in which of the two groups they belong so that the 2-week feedback phase could start.

In order to measure daily objectively physical activity, a tri-axial piezoelectric accelerometer (XSens; The Netherlands) was used. Measuring accelerations in three different axes of the trunk (anteroposterior, mediolateral and longitudinal), the objective activity level was determined. Straining the acceleration with a 4th order Butterworth filter with cutoff frequencies

of 0.11 and 20 Hz, the absolute value of acceleration was combined over 60 seconds and afterwards summed over the three axes.

Subjective activity was measured by asking the participants to give an estimation of their objective activity level. At 19.30 each day the patients rated their subjective activity level on the PDA by ticking a visual analogue scale between 0 (not active) till 10 (maximal active).

Furthermore the participants were asked four times each day (at starting point of the measurement, 12.00, 16.00 and 20.00) to rate their subjective fatigue score on the PDA from 0 (not fatigue) till 10 (maximal fatigue). This variable was added in the course of the study so that only twelve of the 23 participants had the opportunity to report their daily fatigue score.

All data was transmitted through Bluetooth connection to a personal digital assistant (PDA) (Figure 2) to store the measured values. During the measurement periods the participants had to wear the PDA with a belt on the participants' waist between 8.00 and 22.00, besides from water activities.

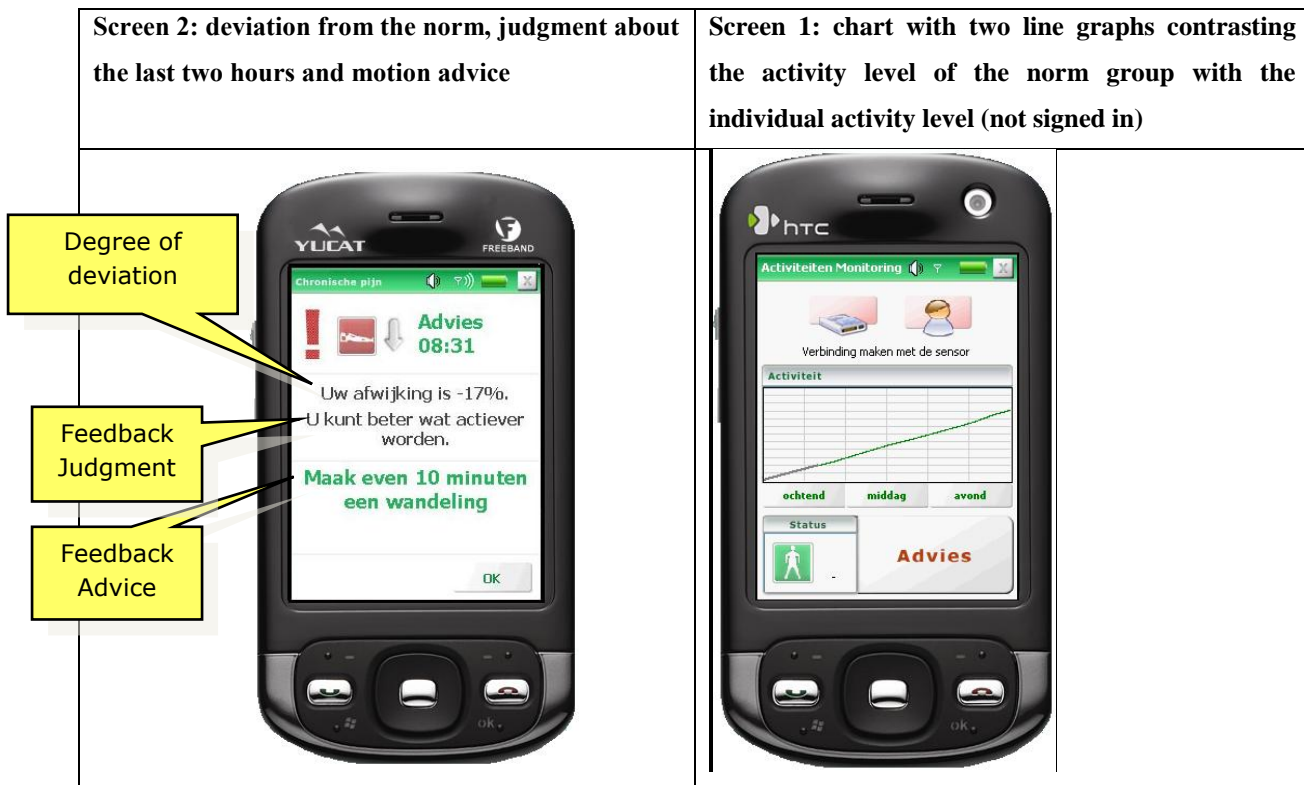


Figure 2: Feedback system with feedback

Data analysis

Objective activity level

The inclusion criteria for subjects in the data analysis were the availability of three measurement days with at least 420 min per day. By using Mat lab an algorithm was written to calculate the mean objective activity level per day. This calculation was used to calculate the mean score of each participant, which then where used for the data analysis.

Subjective activity level

Subjective activity was measured by asking the participants to give an estimation of their physical activity level. At 19.30 each day the patients estimate their physical activity on the PDA by ticking a visual analogue scale between 0 (not active) till 10 (maximal active).

Fatigue Score

Four times each day (at starting point of the measurement, 12.00, 16.00 and 20.00) subjects were asked to rate their subjective fatigue score on the PDA from 0 (not fatigued) till 10 (maximal fatigued). This variable was added in the course of the study so that only twelve of the twenty-three participants had the opportunity to report their daily fatigue score.

Statistical analysis

The study design was a randomized prognostic cohort. The data were collected between November 2008 and February 2011. The Statistical Package for the Social Science (SPSS18) was used to conduct the analysis of the statistical data. The significance level of 0.05 was used for all analyses.

To analyze if there was any scoring difference regarding to education and age of the participants, two One-Way ANOVAs were adopted with education and age as factors and objective, subjective and fatigue scores as dependent variables. To see if there is any relation between gender and study scores an independent-samples t-test was executed, with gender as

grouping variable and the three weekly mean scores of objective, - subjective activity level and fatigue level as test scores.

Due to the fact that data of just half of the subjects fatigue scores were available, an independent sample t-test was adopted to point out if there was a significant difference between the two groups regarding age. Testing whether the groups significantly differentiate according to education and gender a Pearson Chi-Square test was executed. To determine the relations between objective- and subjective activity level and fatigue level a bivariate correlation with a Pearson correlation coefficient was executed three times for each week. Therefore the mean week scores of the three variables had been calculated, because there were too many missing values to calculate the correlation for each day. To analyze if the difference between the mean scores of each variable per week was significant a one-factor repeated measures analysis of variance was adopted.

To investigate the differences between social- and temporal comparison group an independent-samples t-test was used. The grouping factor was comparison group and the test variables were three weekly mean scores of objective- and subjective activity level and fatigue level.

Results

Demographic characteristics

Table 1 gives a detailed overview of the background of the participants according to gender, age and education, separated for social- and temporal comparison group. The groups do not differ significantly from each other regarding gender, which means that distribution is nearly the same in both groups. In total, most of the participants were women (78, 3%). The total mean age was 34; the youngest participant was 18 years and the oldest 56 years. Comparing the mean age, participants of the social comparison group are younger than patients of the temporal group, respectively 32 to 36, which was not found to be significant. The highest degree patients had followed secondary of vocational education (70%). Within the two comparison groups the educational background show different patterns, but these differences were not significant. On the one hand 6 patients in the social comparison group followed secondary education whereas 2 participants of temporal comparison group followed this type of education. On the other hand

vocational education was followed by 6 patients of the temporal group and only 2 participants of the social comparison group. Among all patients, one person had a university degree. Conclusively, there is no significant difference between the two groups regarding gender, age and educational background, respectively ($p = .451$; $p = .989$; $p = .503$). With regard to the fatigue score no significant differences regarding the background characteristics have been found between participants who had the possibility to report their daily fatigue score and those who had not.

Table 1 Demographic characteristics

| Demographic characteristics | | Social Comparison | Temporal Comparison | Total (N) | % in total |
|-----------------------------|---------------------|-------------------|---------------------|-----------|------------|
| gender | Man | 2 (18,2%) | 3 (25,0%) | 5 | 21,7 |
| | Woman | 9 (81,8%) | 9 (75,0%) | 18 | 78,3 |
| age | 18-20 | 3 (27,3%) | 1 (8,3%) | 4 | 17,4 |
| | 21-30 | 3 (27,3%) | 4 (33,3%) | 7 | 30,4 |
| | 31-40 | 2 (18,2%) | 4 (33,3%) | 6 | 26,1 |
| | 41-50 | 2 (18,2%) | 1 (8,3%) | 3 | 13 |
| | 50 and older | 1 (9,1%) | 2 (16,7%) | 3 | 13 |
| education | Secondary education | 6 (54,5%) | 2 (16,7%) | 8 | 34,8 |
| | Vocational | 2 (18,2%) | 6 (50%) | 8 | 34,8 |
| | Degree | 3 (27,3%) | 3 (25%) | 6 | 26,1 |
| | University | 0 (0%) | 1 (8,3%) | 1 | 4,3 |

Baseline

A moderate positive correlation was found between objective- and subjective activity level (table 2). This means that one variable has a positive relation to the other. So it is to say that either the patients realistically estimate their activity level, or the people estimation of physical activity influenced their physical movement. The correlation between objective activity level and the subjective fatigue level was found moderate negative significant. This means in baseline of the study as physical activity increases the participants feel less tired or that when the patients feel

more tired, physical activity decreases. Correlating subjective activity level and fatigue, no significant correlation was found.

Feedback weeks

In feedback week 1 and 2 a significant moderate positive correlation was found between objective- and subjective activity level (table 4). Compared with the results of the baseline week it is to say that the correlation between the two variables constantly grew. This means that either the patients' estimation of their physical activity was getting more accurate in the course of the experiment or their physical activity was adapted to their estimation of their physical activity. During the experiment the mean objective activity level increased constantly (table 2; appendix graph 3), but the increase was found not significant ($p = .480$). Comparing the baseline and the first feedback week, the mean subjective activity level increased and during the two feedback weeks it was the same (table 2, appendix graph 1). This difference was not found significant ($p = .073$). The mean fatigue level increased during the course of the experiment, also this differences are not significant ($p = .233$) (table 2, appendix graph 2).

Table 2 Average score of objective- & subjective activity and fatigue during the three experimental weeks

| | N | Minimum | Maximum | Mean | Std. Deviation |
|-------------------------------|----|---------|---------|-------|----------------|
| Baseline: Objective activity | 22 | 381,6 | 1218,0 | 829,3 | 203,8 |
| Baseline: Subjective activity | 23 | 2,6 | 7,9 | 5,3 | 1,2 |
| Baseline: Fatigue | 9 | 4,7 | 7,2 | 5,5 | 0,8 |
| 1. Feedback Week: | 21 | 417,0 | 1277,0 | 835,6 | 234,9 |
| Objective activity | | | | | |
| 1. Feedback Week: | 20 | 2,2 | 8,4 | 5,8 | 1,4 |
| Subjective activity | | | | | |
| 1. Feedback Week: Fatigue | 9 | 3,0 | 8,4 | 5,6 | 1,6 |
| 2. Feedback Week: | 20 | 426,2 | 1379,2 | 853,4 | 255,5 |
| Objective activity | | | | | |
| 2. Feedback Week: | 20 | 2,5 | 8,7 | 5,8 | 1,4 |
| Subjective activity | | | | | |
| 2. Feedback Week: Fatigue | 8 | 4,9 | 8,1 | 5,7 | 1,3 |
| Valid N (listwise) | 8 | | | | |

Differences between social and temporal comparison group

During baseline week very low, not significant correlation between objective and subjective activity in the social comparison group was found (table 5). In the first feedback week the correlation between the two variables was found to be significant moderate negative. The results of the second feedback week regarding the social comparison group showed also a negative correlation but lower compared to the first feedback week and not significant. During the two feedback weeks in the temporal comparison group the low and not significant correlation of the first week became higher but still was at a low level and also not significant. In contrary to these result during the baseline a strong positive correlation was found in the temporal comparison group. Unless not all correlations are significant, comparing the two groups it is to say that in the social comparison group the negative correlation was getting lower during the feedback weeks and in the temporal group the positive correlation got stronger. Unless no significant difference was found within the two groups regarding objective activity level (p

=.470) it can be stated that in the social comparison group the activity level decreased during the baseline and first feedback week and then increased again in the second feedback week (table 3). During the three weeks in the temporal comparison group a constantly decrease of activity level was found. Comparing the two groups a higher weekly mean score of the activity level was found in the social comparison group. Since in the baseline all patients got the same treatment it has to be pointed out that in the experimental phase, the activity level of the social comparison group first decreased compared with the baseline score and in the temporal comparison group the objective activity increased. The score of the temporal group steadily grew but did not reach the lowest physical activity score of the social comparison group. Thus on average during the whole experiment patients of the social comparison group had a higher physical activity level than patients of the temporal comparison group. Unless the differences regarding subjective activity were not significant within the two groups ($p = .073$), a constantly increase of subjective activity was found in both groups with a higher weekly mean score in the social comparison group regarding all three weeks. Comparing the differences between baseline and feedback weeks it is shown that the estimation of the patients' objective activity grows in both group but with a higher increase in the social comparison group. Referring to the fatigue score also no significant difference within the group was found ($p = .233$). While in the social comparison group patients feel more tired in the first feedback week compared to the baseline, the opposite has been found in the temporal comparison group. Comparing the two feedback weeks the fatigue level of patient in the social comparison group decreased, whereas the weekly mean score of the temporal comparison increased. Regarding the whole experiment the correlation in the social comparison group between objective activity and fatigue was moderate negative significant, with a higher negative correlation in the baseline than in the first feedback week and a higher, almost strong correlation in the second feedback week. In the temporal comparison group the moderate negative correlation of the baseline week between objective activity and fatigue got weaker in the first feedback week and in the second week the correlation was low positive. These correlations are not significant. During the three experimental weeks the correlation between subjective activity and fatigue increased in the social comparison group, but the correlations were low and not significant. In the temporal comparison group there was almost no correlation between the two variables in the baseline week. In the first feedback week the correlation was

low negatively and moderate negative in the second feedback week. None of the correlation was significant.

Table 3 Average score of objective- & subjective activity and fatigue during the three experimental weeks split in comparison group

| Comparison group | | N | Minimum | Maximum | Mean | Std. Deviation |
|---------------------------|---------------------------------------|--------------------|---------|---------|-------|----------------|
| Social comparison group | Baseline: Objective activity | 10 | 638,3 | 1128,4 | 879,6 | 187,5 |
| | Baseline: Subjective activity | 11 | 4,17 | 7,9 | 5,6 | 1,0 |
| | Baseline: Fatigue | 5 | 4,67 | 7,18 | 5,7 | ,9 |
| | 1. Feedback week: Objective activity | 9 | 623,5 | 1055,6 | 873,0 | 159,1 |
| | 1. Feedback week: Subjective activity | 9 | 4,43 | 8,43 | 6,2 | 1,3 |
| | 1. Feedback week: Fatigue | 4 | 4,71 | 8,43 | 6,4 | 1,7 |
| | 2. Feedback week: Objective activity | 9 | 580,5 | 1214,4 | 897,0 | 215,0 |
| | 2. Feedback week: Subjective activity | 9 | 4,83 | 8,71 | 6,2 | 1,21 |
| | 2. Feedback week: Fatigue | 4 | 5,00 | 8,17 | 6,3 | 1,6 |
| | | Valid N (listwise) | 4 | | | |
| Temporal comparison group | Baseline: Objective activity | 12 | 381,6 | 1218,0 | 787,4 | 215,2 |
| | Baseline: Subjective activity | 12 | 2,6 | 6,7 | 5,4 | 1,2 |
| | Baseline: Fatigue | 4 | 4,7 | 5,8 | 5,2 | ,6 |
| | 1. Feedback week: Objective activity | 12 | 417,0 | 1277,0 | 807,6 | 282,8 |
| | 1. Feedback week: Subjective activity | 11 | 2,2 | 8,1 | 5,5 | 1,4 |
| | 1. Feedback week: Fatigue | 5 | 3,0 | 6,0 | 5,0 | 1,2 |
| | 2. Feedback week: Objective activity | 11 | 426,2 | 1379,3 | 817,8 | 289,8 |
| | 2. Feedback week: Subjective activity | 11 | 2,5 | 6,8 | 5,6 | 1,3 |
| | 2. Feedback week: Fatigue | 4 | 4,9 | 5,4 | 5,2 | ,3 |
| | | Valid N (listwise) | 4 | | | |

Table 4 Correlation of objective- & subjective activity and fatigue during the three experimental weeks

| | | Baseline: Objective activity | Baseline: Subjective activity | Baseline: Fatigue | 1. Feedback week: Objective activity | 1. Feedback week: Subjective activity | 1. Feedback week: Fatigue | 2. Feedback week: Objective activity | 2. Feedback week: Subjective activity | 2. Feedback week: Fatigue |
|---------------------|-----------------|------------------------------------|-------------------------------------|----------------------|--|---|---------------------------------|--|---|---------------------------------|
| Objective activity | Pearson | 1 | ,370** | -,382** | 1** | ,388 | ,157* | 1** | ,464 | -,019 |
| | Correlation | | | | | | | | | |
| | Sig. (2-tailed) | | ,000 | ,005 | | ,000 | ,326 | | ,000 | ,907 |
| | N | 128 | 125 | 53 | 113 | 106 | 41 | 107 | 99 | 41 |
| Subjective activity | Pearson | ,370** | 1 | ,040 | ,388 | 1** | ,456 | ,464 | 1** | ,121 |
| | Correlation | | | | | | | | | |
| | Sig. (2-tailed) | ,000 | | ,755 | ,000 | | ,001 | ,000 | | ,423 |
| | N | 125 | 146 | 64 | 106 | 131 | 53 | 99 | 118 | 46 |
| Fatigue | Pearson | -,382** | ,040 | 1 | ,157 | ,456** | 1** | -,019 | ,121 | 1* |
| | Correlation | | | | | | | | | |
| | Sig. (2-tailed) | ,005 | ,755 | | ,326 | ,001 | | ,907 | ,423 | |
| | N | 53 | 64 | 65 | 41 | 53 | 54 | 41 | 46 | 47 |

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Table 5 Correlation of objective- & subjective activity and fatigue during the three experimental weeks split in comparison group

| Comparison group | | | Baseline: Objective activity | Baseline: Subjective activity | Baseline: Fatigue | 1. Feedback week: Objective activity | 1. Feedback week: Subjective activity | 1. Feedback week: Fatigue | 2. Feedback week: Objective activity | 2. Feedback week: Subjective activity | 2. Feedback week: Fatigue |
|---------------------------|---------------------|---------------------|------------------------------|-------------------------------|-------------------|--------------------------------------|---------------------------------------|---------------------------|--------------------------------------|---------------------------------------|---------------------------|
| Social comparison group | Objective activity | Pearson Correlation | 1 | ,052 | -,509** | ,534** | -,320* | -,470* | ,390* | -,212 | -,681** |
| | | Sig. (2-tailed) | | ,706 | ,004 | ,001 | ,028 | ,027 | ,014 | ,157 | ,002 |
| | | N | 57 | 56 | 30 | 38 | 47 | 22 | 39 | 46 | 18 |
| | Subjective activity | Pearson Correlation | ,052 | 1 | ,055 | -,231 | ,399** | ,137 | -,170 | ,409** | ,143 |
| | | Sig. (2-tailed) | ,706 | | ,748 | ,132 | ,002 | ,496 | ,263 | ,002 | ,516 |
| | | N | 56 | 69 | 37 | 44 | 56 | 27 | 45 | 56 | 23 |
| | Fatigue | Pearson Correlation | -,509** | ,055 | 1 | -,648** | ,512** | ,657** | -,101 | ,056 | ,561** |
| | | Sig. (2-tailed) | ,004 | ,748 | | ,005 | ,005 | ,000 | ,632 | ,781 | ,004 |
| | | N | 30 | 37 | 38 | 17 | 28 | 28 | 25 | 27 | 24 |
| Temporal comparison group | Objective activity | Pearson Correlation | 1 | ,536** | -,301 | ,493** | ,132 | -,265 | ,441** | ,262 | ,186 |
| | | Sig. (2-tailed) | | ,000 | ,162 | ,000 | ,312 | ,233 | ,001 | ,056 | ,432 |
| | | N | 71 | 69 | 23 | 59 | 61 | 22 | 52 | 54 | 20 |
| | Subjective activity | Pearson Correlation | ,536** | 1 | ,023 | ,256* | ,235 | -,095 | ,191 | ,256 | -,348 |
| | | Sig. (2-tailed) | ,000 | | ,909 | ,041 | ,054 | ,643 | ,154 | ,051 | ,103 |
| | | N | 69 | 77 | 27 | 64 | 68 | 26 | 57 | 59 | 23 |
| | Fatigue | Pearson Correlation | -,301 | ,023 | 1 | ,425* | ,363 | ,376 | ,182 | ,201 | -,128 |
| | | Sig. (2-tailed) | ,162 | ,909 | | ,043 | ,074 | ,064 | ,442 | ,371 | ,570 |
| | | N | 23 | 27 | 27 | 23 | 25 | 25 | 20 | 22 | 22 |

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Discussion

The problem of patients with CFS is that they move less and therefore hazard that their health status is getting worse. That is the reason why researchers are interested in finding a possibility to increase patients' physical activity. Therefore it is necessary to get further insights into the physical activity pattern of CFS patients. Moreover a change of the situation implies that the people are aware of their physical activity level thus therefore this study also measured the patients' estimation of their physical activity. An important factor of the diseases is the perceived fatigue of the patients so that this study investigated the relation between fatigues regarding the physical activity and its estimation of it. After analyzing the patients daily life pattern regarding the three factors, this study went a step further by examine in how far feedback can influence the patients. The question was if the physical activity, the estimation of it and the fatigue level can be influenced by giving the patients ambulant regular feedback regarding their physical activity. According to the feedback two different conditions had been developed. One half of the patients got feedback according to a norm based on the mean physical activity level of healthy control subjects while the others got feedback according to a norm based on the same healthy control group including an adaption to someone's own physical activity level at baseline. The question is in how far the two different two different norm lines can influence the behavior of the patients. Does the feedback help more to increase physical activity when the mean norm is determined adapt to one's own physical activity level or is it more helpfully to get the activity advice determined on a norm only based on healthy control subjects?

Implications for results

According to the analyzed data there is a moderate positive significant correlation between subjective and objective activity. This means that if one value increased, the other one increased as well. Since the two variables have different measurement units in this study no statistically analysis according to the causation could be executed, but other researcher found that "subjective outcome assessments result more often in significant lower physical activity levels" (Evering, Weering, Groothuis-Oudshoorn, & Vollenbroek-Hutten, 2011). These findings imply that physical activity is influenced by subjective physical activity. For that reason the research question better should be to what extent the estimation of one's activity level influences the activity level. Here it can be hypothesized that if the patients estimate their activity level high the

physical activity also is high and vice versa. This implies that CFS patients realistically estimate their physical activity. Nevertheless, the founding correlation was moderate which means that the participants were not able to estimate their physical movement completely right, but the tendency of rating their physical activity level and the actual level went into the same direction. Since the two variables are measured in different units, it cannot be calculated if the participants under- or overestimate their physical activity level. To factor the feedback week into the results an increase of correlation between objective and subjective activity can be seen. Conclusively it can be stated that feedback had a positive influence on the correlation of the two variables. Studies show that CFS patients often underestimate their physical activity level (Weering, Vollenbroek-Hutten, & Kotte, 2007). In relating to the study results one can hypothesize that the ambulant feedback advice may make the people more alert to their physical activity and therefore rate their physical activity more accurate. Regarding the two comparison groups no significant differences have been detected and also no tendency could be determined.

Statistical analysis shows that there was found a significant negative correlation between objective activity level and fatigue in the baseline week. It has to point out that this correlation was moderate thus the relation been found is not such strong. In various studies of Vercoulen et al. a relation between high fatigue level and low physical activity level was found. In the most recent study researchers even goes a step further and stated that physical activity and fatigue correlated negatively. In the study of Black et. al (2005) there was also found that “overall mood, muscle pain intensity and time spent each day with fatigue worsened following increased activity in the CFS participants” (Black, O’Connor, & McCully, 2005) Other researchers like Fulcher et. al and Manley, observed exactly the opposite, that increasing physical activity results in lower fatigue. Anyway, researchers agree upon the fact that the objective activity level influences the fatigue level and not the other way around. With regards to the present study this would mean that during the baseline when patient’s physical activity level increased they felt less tired.

No significant correlation has been found between subjective activity level and fatigue. With regards to the present study this means that the estimation of one’s activity level has no influence on the fatigue level. Contrary to the findings of Silver et. al this means that the self-assessment does not influence peoples feeling of tiredness.

Although no significant difference between the weekly mean scores of objective activity has been found a constantly increase of the activity was detected. During the feedback weeks CFS patients' physical activity was higher than in the baseline. An explanation that no significance could be stated during the baseline and the feedback weeks could be that participating in a study already has motivated the patients to be more physical active. Therefore the difference between baseline and feedback weeks would be reduced. Based on the results it can be stated that patients of the social comparison group had a higher physical activity than patients of the temporal comparison group. This difference was also detected in the baseline, even though the participants were randomly divided into two groups. This implies that the founding difference in the two feedback weeks already existed in the baseline, which means that no interpretations based on study influences can be made.

Concerning fatigue no significant change has been found. The total fatigue level was almost the same during the whole week. This means that the feedback did not have any effect on the perceived tiredness of the patients. According to the literature research fatigue can be linked with objective activity level. Since the objective activity did not significantly differ during the experiment a logical conclusion is that also the fatigue level did not change. Therefore it would be interesting to know if the fatigue level will change during feedback weeks when the objective activity also increased.

Comparing the scores of the social and temporal comparison group no significant difference between the weekly mean scores has been found, but one can say that patients of the social comparison group by trend are more tired than the patients of the temporal comparison group. The patients of the social comparison group had a norm line based on the physical activity pattern of health people. This implies that on average the participants had to move more than members of the other condition and therefore had a higher fatigue level. Another explanation could be the different objective activity level of the two groups. In the social comparison group patients had a higher physical activity. As seen in results of the baseline a positive correlation between the two variables has been found. Therefore it can be argued that participants of the social comparison group are more tired because on average their activity level is higher compared with the temporal comparison group.

Comparing the correlations of subjective and objective activity level it is to say in the social comparison group the correlations were negative and in the temporal comparison group

the correlations were positive. For the social comparison group this means when objective activity increase patients estimation of the activity level decreased. For patients of the temporal comparison group this means that when the physical activity grew, the estimation of one's activity also grew. Thus people of the temporal comparison group can quite accurately rate their physical activity whereas people of the social comparison group do not. However, not all correlations has been found significant which makes it difficult to interpret the results. Based on the fact that the results show a specific trend it can be hypothesized that participants of the temporal group can estimate their physical behavior. One can explain this difference with regards to the foundations of the feedback. The advices of patients of the temporal group were based on their own physical activity. Therefore their physical activity differ less from the norm line compared with the social comparison group. Deviating from the norm line means that patients got movement advices. Consequently people of the social comparison group were likely to get more advices.

Since the correlations of between objective activity level and fatigue not significant at all, no statements about the relation regarding the two groups can be made.

Regarding the correlation between objective activity and fatigue a increased negative relation has been found in the social comparison group but no significant correlations or trends in the temporal group. Therefore the two groups cannot be compared.

In the two group no significant correlation has been found between subjective activity level and fatigue. However, the correlations of the social comparison groups were positive whereas in the temporal comparison group negative correlations had been found. This trends show that participants of the temporal group feel less tired when rating their physical activity higher and vice versa. To act on the assumption that the estimation of one's physical activity influences the fatigue level it can be stated that participants of the temporal comparison group feel less fatigue when even feel that they had a high physical activity level. For patients of the social comparison this means that when thinking that their physical activity is high they also feel more tired. Since no experiments regarding the relation between self-assessment and fatigue has been done further research is necessary.

Limitations and suggestions for further research

The result of this study has to be interpreted according to the limitations which go along with the experiment. It has to say that many missing values made a data analysis difficult. For that reason it was just possible to calculate with mean scores. This technique actually limits the accurateness of the study and one is forced to examine the data with the help of week mean scores. Several times the mean score could not be determined because of the lack of enough data. A first explanation of the way a lot of data was missing is because there were two subjective variables used. Thus only if it was possible since it is a field experiment these factors could not be influenced by the experimenter. The researchers were dependent on the patients, if they did not continually wear their feedback system, data would be missing. Concerning the fatigue score another explanation is that this score was introduced in the course of the experiment so that just the half of the patients got the possibility to rate their fatigue. Also statistical analysis shows that there were no significant differences between the group with and without fatigue score according to the demographic variables, other factors not measured in this study, could make a difference.

Another limitation is that analyzing the data two SPSS files has been used. When calculating the correlation the data has been restructured. Instead of analyzing the seven scores per week per each participant, the data has been turned so that score two of week one became statistically a new participant. This means that when calculating the correlation, a file with 7x23 participants has been used. These scores came from just 23 participants so that the reliability of the test decreased. Furthermore it must be mentioned that a sample of 23 participants is quite small. As it is generally known this makes the study less reliable and valid. Therefore in further research the number of participants should be raised. A point which made it difficult for data analysis was the different units of subjective and objective measurements. One cannot compare the two units directly and often it was only possible to calculate a correlation, which means that no statements about cause and effect could be made. A suggestion for further research would be to make a scale with which one can compare the objective and subjective measurements. One possibility would be to divide the measurement into different percentage sections. The division can be made as follows: the mean score of the participants is equivalent to 50%. All scores between 50% and 75% are high moderate and scores between 25% and 50% are low moderate. Each score above or underneath are high or rather low. The same has to be calculated for the

subjective activity and the fatigue level with a score of 5 equivalents of 50%. This schedule would make it possible to compare the scores of the three variables with each other.

Moreover concerning the results only moderate correlation had been found which implies that if getting significant results, the relation between the factors was not such strong so one has to make conclusion with caution.

Bibliography

- Bailey, S. (2010). Tired of being tired: Exercise as a treatment for chronic fatigue syndrome. *ACSM's Health & Fitness Journal*, 20-25.
- Besharat, M., Behpajoo, A., Poursharifi, H., & Zarani, F. (2010). Personality and chronic fatigue syndrome: The role of the five-factor model. *Asian Journal of Psychiatry*, 1-5.
- Black, C., O'Connor, P., & McCully, K. (2005). Increased daily physical activity and fatigue symptoms in chronic fatigue syndrome. *Dynamic Medicine*.
- Blacker, C., D.T. Greenwood, K. W., R. Wilson, C. W., Howe, I., & Ali, T. (2004). Effect of galantamine hydrobromide in chronic fatigue syndrome: A randomized controlled trial. *The Journal of American Medical Association*, 1195-1204.
- Blockmans, D., Persoons, P., Houdenhove, B. v., Lejeune, M., & Bobbaers, H. (2003). Combination Therapy with Hydrocortisone and Fludrocortisone does not improve Symptoms in Chronic Fatigue Syndrome: A Randomized Placebo-Controlled, Double-blind, Crossover study. *The American Journal of Medicine*, 736-741.
- Buchwald, D., Pearlman, T., Kith, P., & Schmalting, K. (1994). Gender Differences in Patients with Chronic Fatigue Syndrome. *Journal of General Internal Medicine*, 397-401.
- Chambers, D., Bagnall, A., Hempel, S., & Forbes, C. (2006). Interventions for the treatment, management and rehabilitation of patients with chronic fatigue syndrome/myalgic encephalomyelitis: an updated systematic review. *Journal of the Royal Society of Medicine*, 506-520.
- Clearing-Sky, M. (1988). Exercise: issues for prescribing psychologists. *Psychology and Health*, 189-207.
- Deale, A., Chalder, T., Marks, I., & Wessely, S. (1997). Cognitive behavior therapy for chronic fatigue syndrome: a randomised controlled trial. *American Journal Psychiatry*, 408-414.
- Dubbert, P. (1992). Exercise in behavioural medicine. *Journal of consulting and clinical psychology*, 613-618.
- Evering, R., Weering, M. v., Groothuis-Oudshoorn, K., & Vollenbroek-Hutten, M. (2011). Daily physical activity of patients with the chronic fatigue syndrome: a systematic review. *Clinical Rehabilitation*, 112-133.
- Fischler, B., Dendale, P., Michiels, V., Cluydts, R., Kaufmann, L., & Meierleier, K. d. (1997). Physical fatigability and exercise capacity in chronic fatigue syndrome: association with disability, somatization and psychopathology. *Journal of Psychosomatic Research*, 369-378.

- Fisher, K., & Johnston, M. (1997). Validation of the Oswestry Low Back Pain Disability Questionnaire, its sensitivity as a measure of change following treatment and its relationship with other aspects of the chronic pain experience. *Physiotherapy Theory and Practice*, 67-80.
- Fry, A., & Martin, M. (1996). Cognitive idiosyncrasies among children with the chronic fatigue syndrome: anomalies in self-reported activity levels. *Journal of Psychosomatic Research*, 213-223.
- Fukuda, K., Straus, S. E., Hickie, I., Sharpe, M. C., Dobbins, J. G., & Komaroff, A. (1994). The Chronic Fatigue Syndrome: A Comprehensive Approach to Its Definition and Study. *American College of Physicians*, 953-959.
- Fulcher, K. (1997). Randomised controlled trial of graded exercise in patients with the chronic fatigue syndrome. *British Medicine Journal*.
- Garrakla, M., & Rangel, L. (2001). Childhood chronic fatigue syndrome. *American Journal of Psychiatry*, 1161.
- Gibson, H., Carroll, N., Clague, J., & Edwards, R. (1993). Exercise performance and fatiguability in patients with chronic fatigue syndrome. *Journal Neurological Psychiatry*, 993-998.
- Hu, F., Sigal, R., Rich-Edwards, J., Colditz, G., Solomon, C., Willett, W., et al. (1999). Walking Compared With Vigorous Physical Activity and Risk of Physical Activity and Risk of. *Journal American Medical Association*, 1433-1439.
- Hyong Jin Choa, A. S. (2006). Chronic fatigue syndrome: an update focusing on phenomenology and pathophysiology. *Current Opinion in Psychiatry*, 67-73.
- Inbar, O., Dlin, R., Rotstein, A., & Whipp, B. (2001). Physiological responses to incremental exercise in patients with chronic fatigue syndrome. *Official Journal of the American College of Sports Medicine*, 1463-1470.
- James, A., Bradley, H., Craigie, W., & Onions, C. (1998). *The Oxford English Dictionary*. Oxford: Oxford University Press.
- Jason, L., M.T. Ropacki, N. S., Richman, J., Heatherly, W., Taylor, R., Ferrari, J., et al. (1997). A screening scale for chronic fatigue syndrome: Reliability and Validity. *Journal of chronic fatigue syndrome*, 39-56.
- Jason, L., Richman, J., Rademaker, A. W., Jordan, K., Plioplys, A., Taylor, R. R., et al. (1999). A Community-Based Study of Chronic Fatigue Syndrome. *Arch Intern Med*.
- Jenkins, R., & Mowbray, J. (1991). *The cognitive behavioural management of the post-viral fatigue syndrome*. Chichester : John Wiley and Sons. .

- Komaroff, A., Fagioli, L., Doolittle, T. H., Gandek, B., Gleit, M. A., Guerriero, R. T., et al. (1996). Health Status in Patients with Chronic Fatigue Syndrome and in General Population and Diseases Comparison Groups. *The American Journal of Medicine*, 281.
- Lechner, L., Bolman, C., & Dijke, M. v. (2006). Factors related to misperception of physical activity in The Netherlands and implications for health promotion programmes. *Health Promotion International*, 104-112.
- Lee, C., Simmonds, M., Novy, D., & Jones, S. (2001). Self-Reports and Clinician-Measured Physical Function Among Patients With Low Back Pain: A Comparison. *Arch Physical Medicine Rehabilitation*, 227-231.
- Lee, Y.-C., Chien, K.-L., & Chen, H.-H. (2007). Lifestyle Risk Factors Associated with. *Journal of the Formosan Medical Association*, 565-572.
- Lindal, E., Stefansson, J. G., & Bergmann, S. (2002). The prevalence of chronic fatigue syndrome in Iceland - A national comparison by gender drawing on four different criteria. *NOR DJ Psychiatry*, 274.
- Manley, A. (1996). *Physical Activity And Health: A Report Of The Surgeon General*. Atlanta: U.S. department of health and human services.
- Manu, P. (1998). *Functional Somatic Syndromes: Etiology, Diagnosis and Treatment*. Cambridge University Press.
- Marshall, G. (1999). Report of a workshop on the epidemiology, natural history and pathogenesis of chronic fatigue syndrome in adolescents. *Journal of Pediatrics*, 395-405.
- McCully, K., Sisto, S., & Natelson, B. (1996). Use of exercise for treatment of chronic fatigue syndrome. *Sports Medicine*, 35-48.
- P.D.Thompson, D. Buchner, I. P., Balday, G., Williams, M., Marcus, B., Berra, K., et al. (2003). Exercise and Physical Activity in the Prevention and Treatment of Atherosclerotic Cardiovascular Disease: A Statement From the Council on Clinical Cardiology (Subcommittee on Exercise, Rehabilitation, and Prevention) and the Council on Nutrition, Physical. *Journal of the American Heart Association*, 1-8.
- Peterson, P., Shephard, J., Marces, M., Schenk, C., Crosson, J., Rechtsman, D., et al. (1990). A controlled trial of intravenous immunoglobulin G in chronic fatigue syndrome. *The American Journal of Medicine*, 554-560.
- Powell, P., Bentall, R. P., Nye, F. J., & Edwards, R. H. (2004). Patient education to encourage graded exercise in chronic fatigue syndrome. *The British Journal of Psychiatry*, 142-146.
- Powell, R., R.Dolan, & Wessely, S. (1990). Attributions and self-esteem in depression. *Journal Psychosomatic Research*, 665-673.

- Prins, J., Bleijenberg, G., Bazelmans, E., Elving, L., Boo, T. d., Severens, J., et al. (2001). Cognitive behaviour therapy for chronic fatigue syndrome: a multicentre randomised trial. *The Lancet*, 841-845.
- Reeves, W. C., Wagner, D., Nisenbaum, R., & Jones, J. F. (2005). Chronic Fatigue Syndrome – A clinically empirical approach to its. *BMC Medicine* , 1741-7015.
- Rimes, K., & Chalder, T. (2005). Treatments for chronic fatigue syndrome. *Occupational Medicine*, 32-39.
- Roland, M., & Morris, R. (1982). A Study of the Natural History of Back Pain: Part I: Development of a Reliable and Sensitive Measure of Disability in Low-Back Pain. *Spine*, 141-144.
- Rowe, K. (1996). Double-blind randomized controlled trial to assess the efficacy of intravenous gamma globulin for the management of chronic fatigue syndrome in adolescents. *Journal psychiat. Research*, 133-146.
- Sharpe, M., Hawton, K., Simkin, S., Surawy, C., Hackmann, A., Klimes, I., et al. (1996). Cognitive behaviour therapy for the chronic fatigue syndrome: a randomized controlled trial. . *British Medical Journal*, 22-26.
- Silver, A., Haeney, M., Vijayadurai, P., Wilks, D., Pattrick, M., & Main, C. (2001). The role of fear of physical movement and activity in chronic fatigue syndrome. *Journal of Psychiatric Research*, 485-493.
- Vanness, J., Snell, C., Strayer, D., Dempsey, L., & Stevens, S. R. (2003). Subclassifying Chronic Fatigue Syndrome through Exercise Testing. *Medicine & Science in Sports & Exercise*, 908-913.
- Vercoulen, J., Bazelmans, E., Swanink, C., Fennis, J., Galama, J., Jongen, P., et al. (1997). Physical activity in chronic fatigue syndrome: Assessment and its role in fatigue. *Journal psychiatric Research*, 661-673.
- Vollmer-Conna, U., Hadzi-Pavlovic, D., Tymms, K., Wakefield, D., Dwyer, J., & Lloyd, A. (1997). Intravenous immunoglobulin is ineffective in the treatment of patients with chronic fatigue syndrome. *The American Journal of Medicine*, 38-43.
- Wearden, A., Morriss, R., Mullis, R., Strickland, P., Pearson, D., Appleby, L., et al. (1998). Randomised, double-blind, placebo-controlled treatment trial of fluoxetine and graded exercise for chronic fatigue syndrome. *British Journal Psychiatry*, 485-490.
- Weering, M. v., Vollenbroek-Hutten, M., & Kotte, E. (2007). Daily physical activities of patients with chronic pain or fatigue versus asymptomatic controls. A systematic review. *Clinical Rehabilitation*, 1007-1023.
- Werf, S. v., J.B. Prins, J. V., Meer, J. v., & Bleijenberg, G. (2000). Identifying physical activity patterns in chronic fatigue syndrome using actigraphic assessment. *Journal of Psychosomatic Research*, 373-379.

Wessely, S., & Powell, R. (1989). Fatigue syndromes: a comparison of chronic "postviral" fatigue with neuromuscular and affective disorders. *Journal of Neurological Psychiatry*, 940-948.

Wessely, S., Nimnuan, C., & Sharpe, M. (1999). Functional somatic syndromes: one or many? *The Lancet*, Vol 354.

Wessely, S., Nimnuan, C., & Sharpe, M. (1999). Functional somatic syndromes: one or many? *The Lancet*, Vol 354.

Wessely, S., Nimnuan, C., & Sharpe, M. (1999). Functional somatic syndromes: one or many? *Lancet*, 936-939.

Whiting, P., Bagnall, A., Sowden, A., Cornell, J., Mulrow, C., & Ramirez, G. (2001). Interventions for the treatment and management of Chronic Fatigue Syndrome. *Journal American Medicine Association*, 1360-1368.

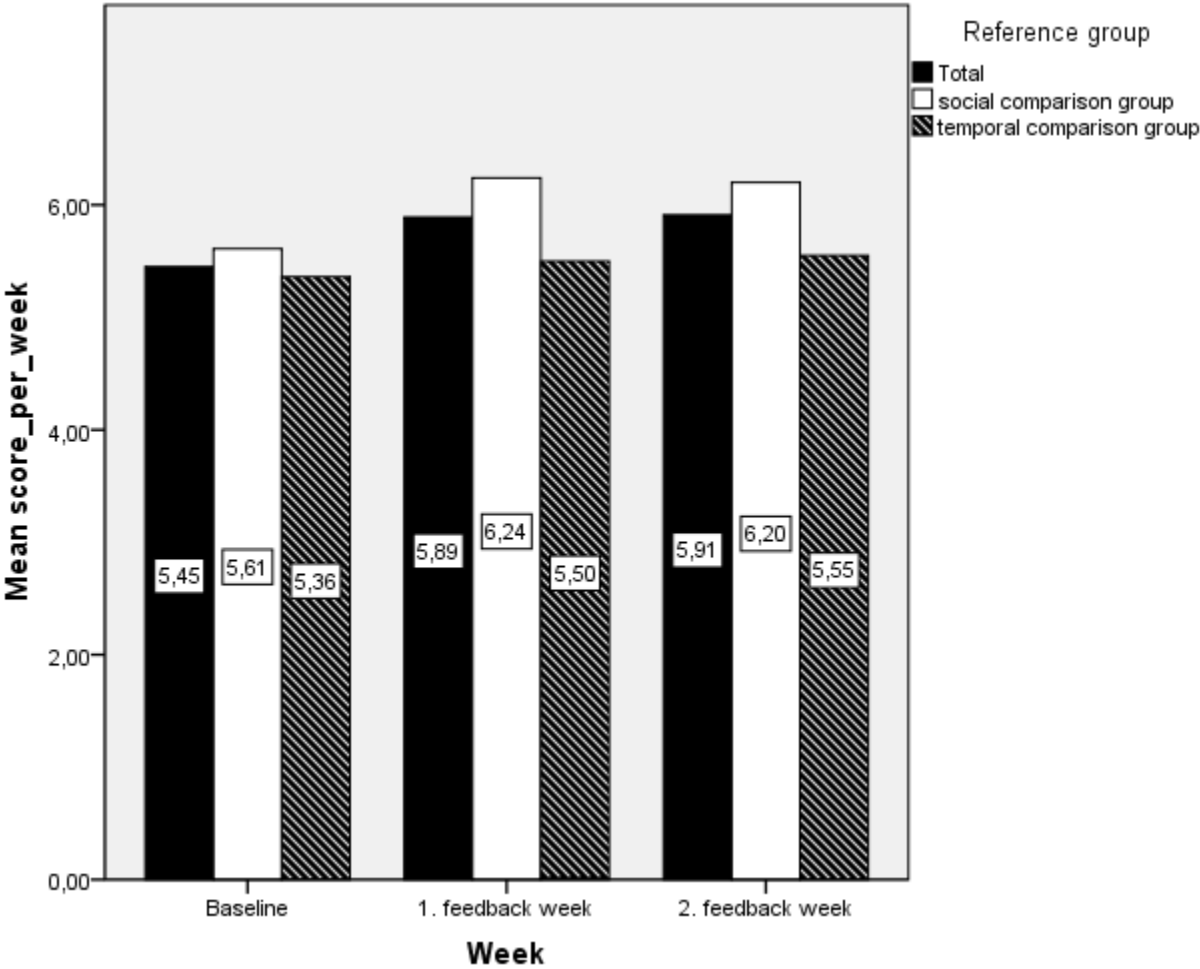
Appendix

Treatment

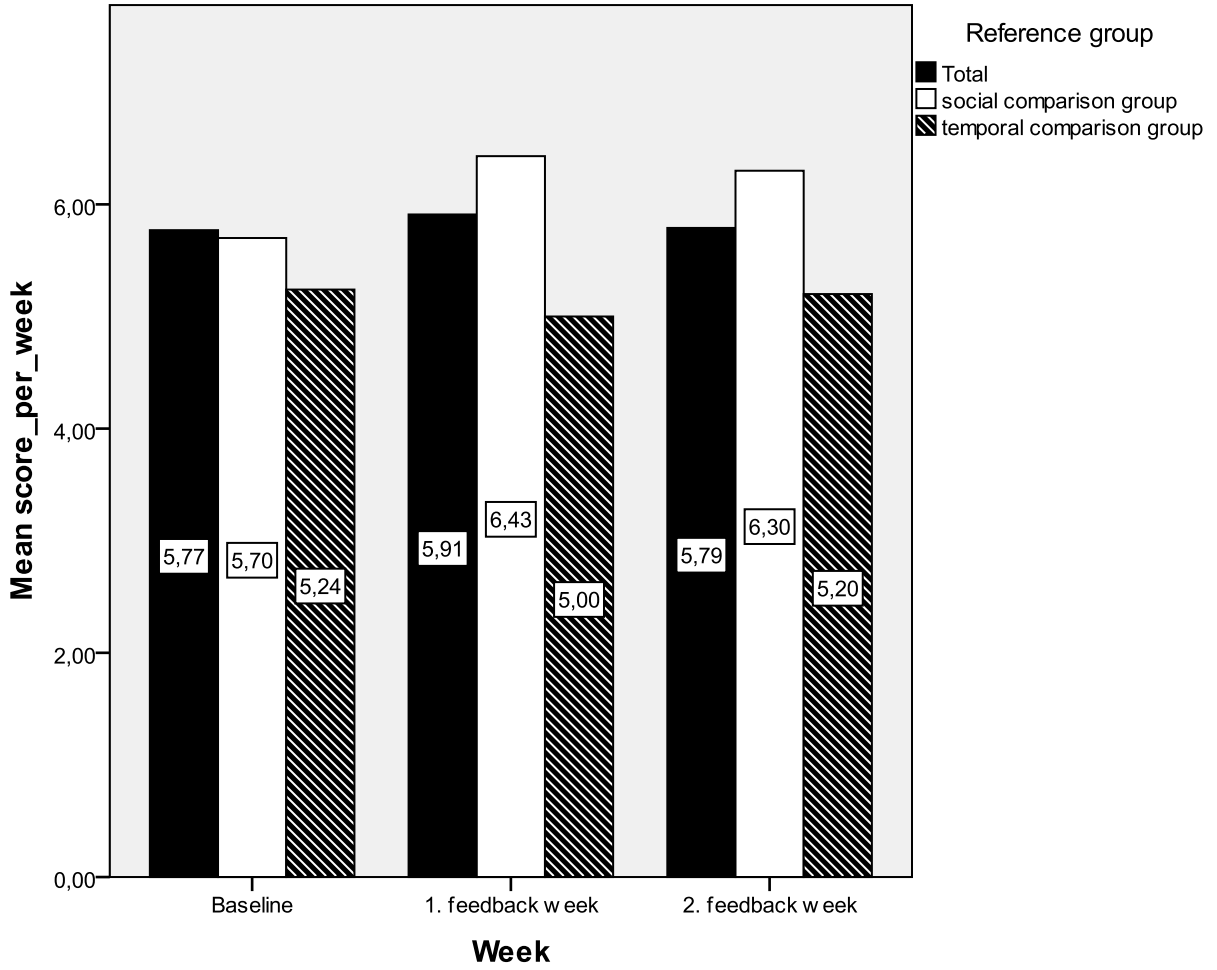
Since researchers are disagreeing about the diagnostic criteria, they also debate about the right treatment of the syndrome. In most of the cases an intervention of treatment is based on pharmacological-, immunological-, graded exercise-, or cognitive behavior therapy (Rimes & Chalder, 2005). Studies using pharmacological therapy as treatment for CFS patients show no significant improvements at all (Blacker, Greenwood, Wilson, Howe, & Ali, 2004; Blockmans, Persoons, Houdenhove, Lejeune, & Bobbaers, 2003; Chambers, Bagnall, Hempel, & Forbes, 2006). Regarding the immunological therapy, the same results are found (Vollmer-Conna, Hadzi-Pavlovic, Tymms, Wakefield, Dwyer, & Lloyd, 1997; Peterson, et al., 1990; Rowe, 1996). Contrary to the effects of pharmacological and immunological therapies, when graded exercise therapy was used an overall beneficial effect was found (Whiting, Bagnall, Sowden, Cornell, Mulrow, & Ramirez, 2001). This therapy is some kind of structured activity management program, which is based on the idea that increasing daily activity, usually walking, has a positive effect on CFS patient.

Like graded exercise therapy, cognitive behavior therapy also showed positive results concerning the improvement of patients' lives. The aim of cognitive-behavioral treatments is to analyze the patients' thoughts about CFS and the handling with it, with the intention to point out factors which may be perpetuating the patient's symptoms (Rimes & Chalder, 2005). By changing this cognitions and behavior, the patients' well-being should be improved, which is confirmed by several studies (Deale, Chalder, Marks, & Wessely, 1997; Prins, et al., 2001; Sharpe, et al., 1996).

Graph 1 Distribution of the subjective activity level during the experiment, split in comparison groups and total score



Graph 2 Distribution of the fatigue level during the experiment, split in comparison groups and total score



Graph 3 Distribution of the objective activity level during the experiment, split in comparison groups and total score

