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## Coping styles and the pathophysiology of energy metabolism

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# CHAPTER 8:



## **Personality types and the success of life style intervention programs: a study in humans.**

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**Abstract:**

With the increasing incidence of obesity and its associated pathologies the need for successful life style intervention programs is increasing as well. Based on our previous studies in experimental animals, we hypothesize that the personality of the individual serves as a crucial factor that may predict the success of a weight loss intervention program. In the current study we aimed to translate our findings from the rat studies to the human population and performed two life style intervention studies with overweight human volunteers with a known personality. The most striking finding in the present study were: 1) passive individuals perform better than proactive individuals in a training program, 2) passive individuals compensate for an increased training activity by reducing spontaneous activity on non training days, 3) there were no differences in success rate between passive and proactive individuals on a moderate diet-and-activity based intervention program. In conclusion, the data from the present study reveal that the personality of the individual may serve as a crucial factor that may predict the relative success of an exercise-based weight loss intervention program. The results of the present study are remarkably similar to data from our previous experiments in rats, indicating that the rat studies might be translated to the human population. The studies also provided convincing evidence for the existence of an endogenous mechanism that may regulate an individual's total activity on a day to day basis.

## **1. Introduction:**

With the increasing incidence of obesity and its associated pathologies the need for successful life style intervention programs is increasing as well. Since the origin of the obesity epidemic seems to lie in an increased consumption of palatable high energy foods combined with a strong reduction in daily physical activity, most treatment programs focus on decreasing food intake and increasing energy expenditure. For at least a part of the population, life style intervention programs have proven to be successful in reducing health risks. However, there are large individual differences in the success rate of these programs (1;2). The most striking example is of an obese woman who followed a strict low calorie diet for 15 weeks. Surprisingly, at the end of 15 weeks of treatment her body weight had increased. It turned out that during the diet, the woman's daily resting metabolic rate changed from 1479 kcal/24h at baseline to 927 kcal/24h at the end of the intervention (3). This example shows that it is difficult to predict an individual's chance of success in any weight loss program by simply the compliance to the intervention program.

We hypothesize that the personality of the individual serves as a crucial factor that may predict the relative success of a weight loss intervention program. Indeed, several studies have investigated the role of the personality in weight loss programs and found that personality has an impact on both surgical and behavioral treatments against obesity. The data of these studies were, however, not easy to interpret, sometimes even conflicting (4-6). Therefore we performed a series of studies in experimental rats and provided convincing evidence that personality indeed plays an important role in predicting the outcome of both diet and exercise based interventions (7-9).

In the current study we went back from bench to bed and aimed to translate our findings from the rat studies to the human population. To this end we performed two studies with overweight human volunteers with a known personality. The first study focused on the potential differences between passive and proactive individuals in the success rate of an exercise based intervention program. The second study focused on the possible differences between passive and proactive human volunteers in the success rate of a more moderate diet-and-activity based intervention program.

## 2. Materials and methods

### 2.1 Personality:

We used two different questionnaires to determine the personality types. Both questionnaires divide the population into so-called proactive Type A or passive Type B personalities. In the first study the Bortner scale (10) was used. Proactive individuals score high and passive individuals score low on this scale. With this questionnaire we selected the 6 highest and 6 lowest scoring individuals out of a population of 24 individuals. The individuals with intermediate scores were not included in the results.

In the second experiment we determined the coping strategy of the individuals with the Utrecht Coping List (UCL; (11)). This scale measures several aspects of behavior but we only used the score on the passive / active coping axis, which is very similar to the type A / Type B axis measured with the aforementioned Bortner scale. A high the score on the UCL scale reflects a passive coping style. Again we selected the 6 highest and the 6 lowest scoring individuals (selected out of a population of 16 individuals).

### 2.2. Activity measurements:

Daily activity was measured with a Personal Activity Meter (PAM). The PAM is a validated uni-axial accelerometer (28 gram). The PAM measures acceleration in the vertical plane with a sensitivity of 2 mV/G by means of a piezoelectric sensor. The acceleration signal is filtered (0.1-5 Hz) and integrated in a capacitor. The voltage of the capacitor is measured each second and digitized by an analog-to-digital converted (ADC) which gives an ADC score per second. In the microprocessor the ADC score is averaged per 24h resulting in a PAM score (12). Additionally, the number of minutes spent in at a certain acceleration is measured. Activity at a low acceleration are referred as the "Low Zone" score and activity at medium and high acceleration are combined in the "Sport Zone" score. The participants were instructed to wear the PAM from awaking until going to sleep. The PAMs were attached to clothing around the hip. And participants were instructed to attach the PAM at the same point throughout the measurement periods. The participants were also asked to write down any activity at which they were not able to wear the PAM meter, like swimming.

### 2.3 Experiment 1: Exercise based intervention

24 healthy moderately obese adults (aged between 20-60 years) were recruited. Most of them were staff of either the *Provincie Groningen* or the *University of Groningen*. All participants had a BMI above 25 (average 29.9 kg/m<sup>2</sup>). Participants were

excluded if they had 1) physical problems (other than obesity) limiting their exercise capacity or 2) if they were already participating in a life style intervention program.

Baseline PAM measurements of daily activity were performed during the first two weeks of the experiment. In this period, the participants filled out the coping style questionnaire and baseline measurements of body weight, height and waist circumference were performed. After the baseline period, an exercise program started with two training sessions per week, for a total of six weeks. A training session consisted of 30 minutes aerobic training followed by 30 minutes resistance training. Trainings intensity was estimated at 7 metabolic equivalents (MET) ( $\text{MET (pam)} = (\text{Pam score}/100 + 1) * 10/9$  (12)). During the exercise program daily physical activity was monitored using the PAM-meters. After six weeks, the body weight and waist circumference was measured to determine success of the intervention.

It could not be excluded that increased physical activity on training days would be, at least in part, compensated by reduced activity on the non-training days. To investigate such a compensatory response, we decided to split the participants after three weeks in two groups of 12 participants. Both groups continued the standard exercise program, but one group (the informed group) was also motivated to remain active on the non-training days. These participants attended a presentation on the concept of non-exercise activity thermogenesis (NEAT) as described by Levine (13). During this presentations suggestions were given how to increase NEAT and the participants were asked to increase their daily NEAT. The other group served as control (uninformed group). Personalities were randomly assigned over the two groups. However, due to the limited number of participants, we could not differentiate between passive and proactive individuals in this part of the study

#### 2.4 Experiment 2: Diet-and-activity based intervention

16 healthy obese adults (aged between 20-60 years) were recruited from the Sleep Apnea clinic of the Martini Hospital. The participants all had a BMI above 30 (average  $35.2 \pm 4.3 \text{ kg/m}^2$ ). Individuals were excluded if they had physical problems limiting their exercise capacity (other than obesity), and if they were already participating in a life style intervention program.

In the first week of the study, baseline measurements of body weight, height and waist circumference were performed and the subjects were asked to fill out the coping style questionnaire. Baseline PAM activity was measured during the first two weeks of the experiment. In the second week of the baseline measurements, we asked the participants to fill out a food diary to monitor their daily intake patterns. The participants were instructed to

fill out the diary for 7 consecutive days, which is sufficient to provide a reliable indication of an individual's dietary habits (14). After this 2-weeks baseline period the participant met with a dietitian in training (supervised by a licensed dietitian) who gave the participant a personalized dietary advice. The advice was based on their intake recorded in the food diary during the baseline week. The extra health advice was mainly a request to increase their NEAT, similar to the end-advice in Experiment 1. We then let the participants undisturbed for two weeks, in which they were required to wear the PAM for another two weeks. In the third week of the experiment, the participants were asked to fill out the food diary for another week. Four weeks after the dietary advice was given a final measurement was made, during which their body weight, waist circumference and fat mass was reassessed.

### 2.5 Data analysis:

The data of Experiment 1 were calculated as averages with standard error of the mean. The differences between baseline and training conditions were statistically tested with repeated measures ANOVA with personality as the between subjects factor. The activity on the non training days was calculated as percentage of the baseline activity. Differences between baseline and non training day activity were analyzed with repeated-measured ANOVA for the passive and proactive individuals separately. The data of last part of Experiment 1 were expressed as averages with standard error of mean. The differences between the first three weeks and the second three weeks were statistically compared with repeated measures ANOVA with level of information as between subjects factor. The data of Experiment 2 were expressed as averages with standard error of mean. The differences before and after diet intervention were statistically tested with repeated measures ANOVA with personality as between subjects factor. For all statistical analysis a confidence interval of 5% was used.

### 3. Results:

#### 3.1 Experiment 1: an exercise based intervention

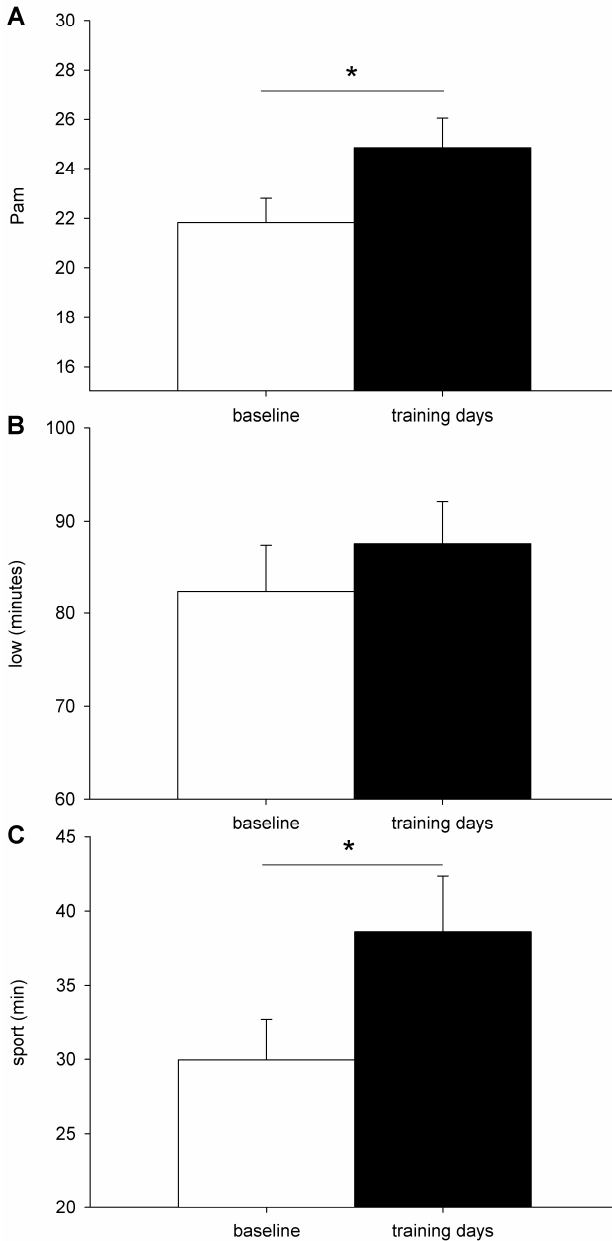
Figure 1 provides the absolute activity scores of all 24 participants in the baseline period and on the training days in the first 3 weeks of the intervention. Figure 1a shows the total PAM score. Training significantly increased the PAM score (1A) (RM-ANOVA  $F(1, 23) = 10.1140$   $p < 0.05$ ,  $29.9 \pm 5.7$  % increase), as well as the time spent in the sport activity zone (1C) (RM-ANOVA  $F(1, 23) = 17.495$   $p < 0.01$ ,  $65.5 \pm 16.3$  %). The increase on training days in the time spent low activity zone (1B) did not reach statistical significance ( $p = 0.087$ ,  $17.0 \pm 5.2$  %).

Table 1 provides the effect of the exercise intervention program on the body mass index (BMI) and waist circumference. Both BMI and waist circumference was significantly lowered in both proactive and passive coping individuals (RM-ANOVA  $F(1, 23) = 12.510$   $p < 0.05$ ,  $2.4 \pm 0.7\%$  and RM-ANOVA  $F(1, 23) = 13.174$   $p < 0.05$ ,  $2.1 \pm 0.5$  %, respectively), even after such a short training period. There were no differences between passive and proactive coping individuals under any circumstances.

**Table 1:** Body weight and waist circumferences of passively and proactively coping individuals before and after the exercise intervention. \* indicates a significant difference before and after the intervention (within a personality).

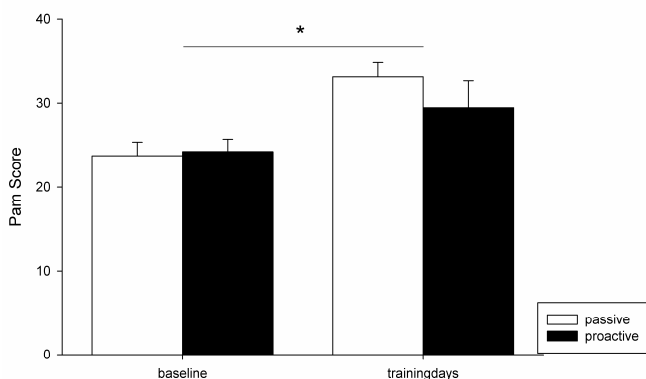
	passive	proactive
BMI before (kg/m <sup>2</sup> )	31.8 ± 1.9	30.7 ± 2.5
BMI after (kg/m <sup>2</sup> )	31.1 ± 0.7 *	29.8 ± 3.1*
Waist circumference before (cm)	109.5 ± 7.3	102.7 ± 9.1
Waist circumference after (cm)	108.0 ± 6.3 *	100.4 ± 13.0 *





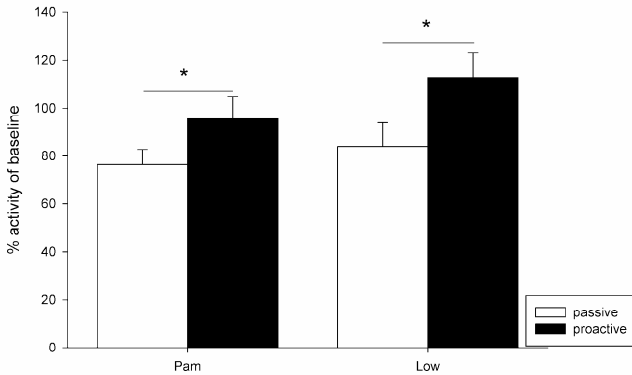
**Figure 1:** The average total daily activity of all participants during the baseline period and on training days. **A:** PAM score, **B:** time spent in low activity zone, and **C:** time spent in sport activity zone. White bars is baseline period, black bars are training days. \* indicates a significant difference between baseline and training days ( $p < 0.05$ ).

Figure 2 shows the PAM scores at baseline and on training days in the intervention period in passive and proactive individuals. At baseline there were no differences between PAM scores of proactive and passive personalities. Both groups increased their daily activity during training. The increase by itself was significant in the passive coping individuals but not in the proactive individuals (Passive individuals: RM-ANOVA time  $F(1,11) = 3.458$   $p < 0.05$  Passive:  $37.5 \pm 12.0\%$  increase; Proactive  $11.2 \pm 7.9\%$  increase). In addition, the individual change in PAM score between baseline and training days was significantly larger in the passive individuals when compared to the proactive ones (RM-ANOVA personality\*time interaction  $F(3, 21) = 9.421$   $p < 0.05$  ).



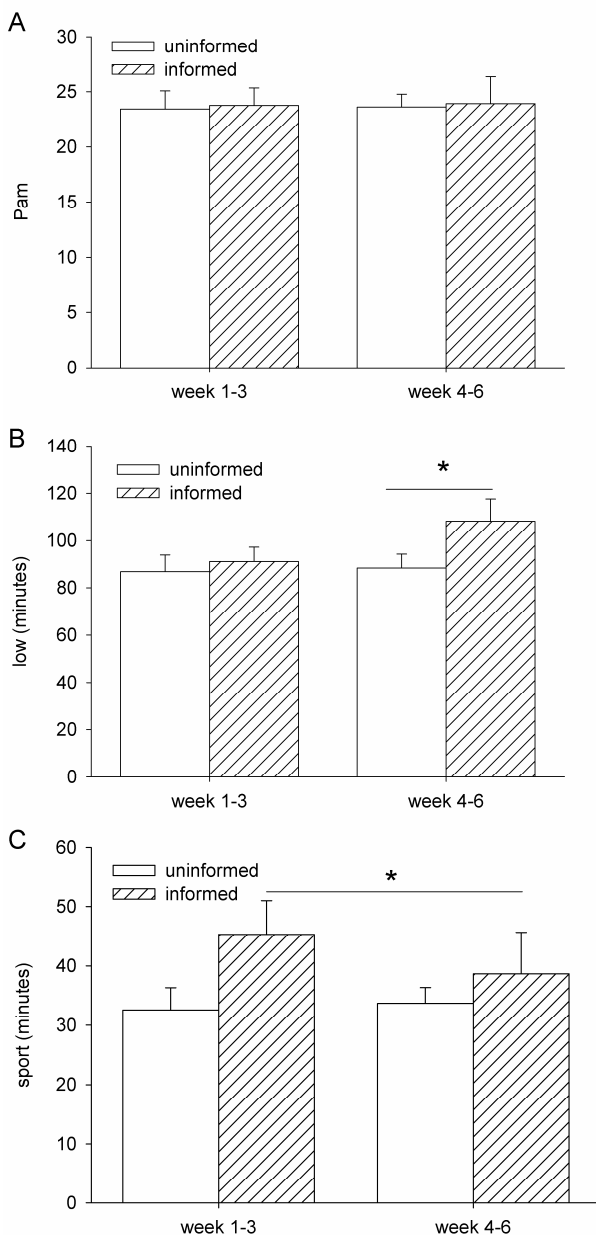
**Figure 2:** Total daily activity of passive and proactive personalities on baseline and training days. White bars represent passive personalities, black bars represent proactive personalities. \* indicates a significant difference between baseline and training days.

Figure 3 shows PAM scores and the time spent on low activity on non training days in passive and proactive individuals during the exercise intervention. The data are expressed as percentage of the activity on similar days in the baseline period. Passive individuals were significantly less active on non training days when compared to the proactive individuals for both activity zones (PAM: RM-ANOVA time\* personality interaction  $F(3,21) = 3.394$   $p < 0.05$ ; Low zone: RM-ANOVA time\* personality interaction  $F(3,21) = 4.786$   $p < 0.01$ ). The reduction from baseline was significant for both activity zones in the passive but not in the proactive individuals (Passive individuals RM-ANOVA time  $F(1,11) = 13.485$   $p < 0.01$ ).



**Figure 3:** PAM scores and the time spent on low activity on non training days in passive and proactive individuals during the exercise intervention. Data are expressed as percentage of the activity on similar days in the baseline period.. White bars represent passive personalities, black bars represent proactive personalities. \* indicates a significant difference passive and proactive individuals

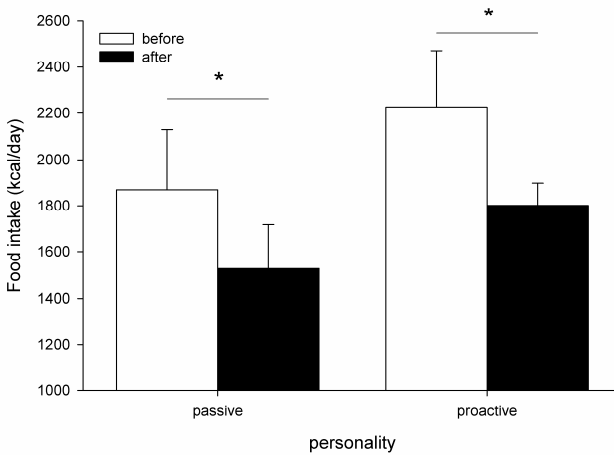
In the second part of experiment 1, the participants were divided in two groups and one group (informed group) was motivated to increase their daily non-exercise activity thermogenesis (NEAT). Figure 4 displays activity scores of the informed and the uninformed group. In the first three weeks of the experiment, thus before the participants were informed, there were no differences in activity scores between the two groups. The individuals in the informed group significantly increased their low zone activity scores in comparison to their scores in the first three weeks of the experiment (RM-ANOVA  $F(1,10) = 5.524$   $p < 0.05$ ). The low zone activity scores in the informed group were also significantly higher than the scores in the uninformed group ( $p < 0.05$ ). The sports zone activity scores were completely opposite: individuals in the informed group significantly reduced their sports zone activity scores in comparison to first three weeks of the experiment (informed: RM-ANOVA time  $F(1,10) = 4,318$   $p < 0.05$ ). The differences in the sports zone activity scores between the informed and uninformed groups were not significant. There were no differences in the PAM scores.



**Figure 4:** Total daily activity scores of the informed and uninformed group in the first and second three weeks of Experiment 1 **A:** total daily PAM score. **B:** time spent in the low activity zone **C:** time spent in the sport activity zone. White bars = uninformed group. Hatched bars = informed group. \* indicates a significant difference ( $p < 0.05$ ).

3.2 Experiment 2: Diet-and-activity based intervention

Figure 5 displays total daily food intake before and after the intervention. At baseline there were no significant differences between the passive and proactive individual in their food intake, although there was a trend that proactive personalities seem to eat more ( $p = 0.078$ ). After dietary advice both groups significantly lowered their caloric intake ( $F(1, 13) = 5,0457$   $p < 0.05$ ,  $13.2 \pm 6.4$  % decrease). There was no interaction between personality and time, suggesting that passive and proactive individuals responded similar to the dietary advice.



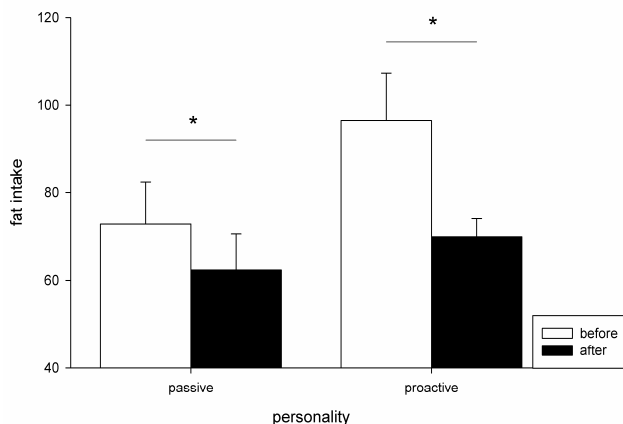
**Figure 5:** Total daily food intake before and after dietary advice in passive and proactive personalities. White bars = before dietary advice, black bars = after dietary advice. \* indicates a significant difference ( $p < 0.05$ ).

Table 2 provides body weights and waist circumferences of passive and proactive individuals before and after the diet-and-activity intervention. There were no significant differences in any of the parameters measured

**Table 2:** Body weight and waist circumferences of passive and proactive individuals before and after the diet-and-activity intervention.

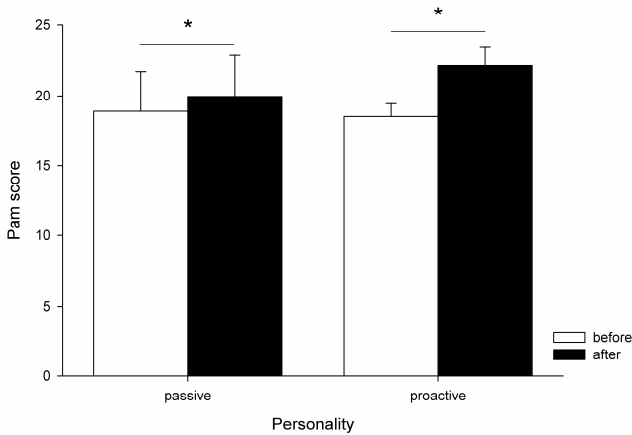
	passive	Proactive
BMI before (kg/m <sup>2</sup> )	34.8 ± 2.2	35.4 ± 1.3
BMI after (kg/m <sup>2</sup> )	34.9 ± 2.4	35.3 ± 1.3
Waist circumference before (cm)	114.7 ± 3.9	120.8 ± 2.4
Waist circumference after (cm)	114.6 ± 3.9	119.8 ± 1.9

Figure 6 displays the total fat intake before and after the intervention. At baseline the diet of the passive personalities contained significantly less fat than that of the proactive personalities ( $F(1,13) = 7,654$   $p < 0.05$ ). Both groups reduced their fat intake after dietary advice ( $F(1,13) = 5,087$   $p < 0.05$ ,  $19.1 \pm 8.1\%$ ). There was no significant difference between the personalities.



**Figure 6:** Total daily fat intake before and after the dietary advice in passive and proactive personalities. White bars represent passive personalities, black bars represent proactive personalities. \* indicates a significant difference ( $p < 0.05$ ).

The daily activity scores before and after the diet-and-activity advice are presented in figure 7. During baseline measurements there were no differences between passive and proactive individuals in total daily activity. Both total daily activity expressed as PAM score ( $F(1,13) = 7.020$   $p < 0.05$ ,  $13.7 \pm 5.1\%$  decrease) and time spent in the sport zone ( $F(1,13) = 7.757$   $p < 0.05$ ,  $19.8 \pm 4.6\%$  decrease) significantly increased in both personality groups. The effects seemed more pronounced in the proactive individuals, it did, however, not reach statistical significance.



**Figure 7:** Total daily activity before and after the dietary advice in passive and proactive personalities. White bars represent passive personalities, black bars represent proactive personalities. \* indicates a significant difference ( $p < 0.05$ ).

#### 4. Discussion:

The current study investigated the role of the personality in the potential success of a life style intervention. Based on our previous studies in rats (7-9), we expected that individuals characterized by a passive personality would be more successful in a exercise based life style intervention program. The results of the present study in humans seem to confirm this, at least in part. In experiment 1, the performance of the passive personalities, reflected by the PAM and sports zone scores, was significantly better than that of the proactive personalities. This finding is remarkable similar to our previous findings in rats, confirming the face validity of the rat model.

These differences in training activity may be due to a different response to the instructions given by the trainers. Passive personality types are known to be more sensitive to external motivation (15). This may have lead to a higher motivation to exercise in a guided setting, although our instructors failed to notice a difference in motivation or adherence between the passive and the proactive individuals. Our data are, in part, supported by previous observation by *Sullivan and colleagues (16)* who showed that individuals that were successful in losing weight in a inpatient highly supervised intervention were characterized by low scores for novelty seeking, a personality trait consistent with a passive personality. From these data one may speculate that, since passive personality types seem more sensitive to external motivation, highly supervised training programs, such as training with a personal trainer, might be particularly effective for these individuals. In contrast, proactive

personality types are less sensitive for external motivation and seem mostly driven by competition (17). Therefore competition sports or training in a group of peers, would be a better suited for the proactive individuals.

Based on the differences in training activity, one would expect that the passive personalities would be more successful in terms of weight loss or reduction of waist circumference. However, there were no differences between the proactive and passive personalities in this: they both improved. The reason for this is clear: the passive individuals compensated for the extra trainings activity by reducing their spontaneous low zone activity on the non training days. Although we cannot rule out that the decrease in spontaneous activity was a conscious decision of the participants, this compensatory reduction in spontaneous activity seems a striking example of the Activity-Stat, previously defined by Wilkin and colleagues: total activity is regulated, probably by a centrally mediated mechanism (18-21). At this point, one should note however, that, although increased training activity might be compensated, an exercise intervention program still leads to an improvement in BMI and weight circumference and, most tenable, in (patho)physiological parameters (reviewed in (22)).

Proactive individuals did not compensate at all for the increased training activity, which confirms their pre-programmed routine-like personality. One may speculate that there is an evolutionary basis for the differential response between the personalities. Historically, the passive personality type is better suited to variations in their environment, therefore these individuals seem to display more flexibility in their behavioral patterns. Proactive behavioral strategies are highly successful in stable environments, therefore routine formation is strongly associated with a proactive behavioral style (23). This difference in behavioral flexibility may result in a different strategy to compensate for increased physical activity during the intervention.

In the second part of Experiment 1, we tried, in half of the participants, to avoid the compensatory reduction in activity on non training days by motivating them to remain active outside training sessions (information on NEAT). The information proved very effective: the informed group remarkably increased their low zone activity. However, this did not lead to an increase in total PAM score over the weeks because the informed participants unknowingly reduced their sport zone activity score. This reduction in training activity was not noticed by the coaches. This surprising compensatory reduction in training performance due to an increased NEAT may be considered, again, as striking evidence for the above mentioned Activity-Stat (18;21). Unfortunately, the low number of participants did not allow distinguishing between the proactive and passive individuals in this part of the study.



In the second study we further investigated the difference between passive and proactive personalities in a life style intervention program. This second study used a more moderate intervention based on a personalized dietary advice and a general request to increase daily activity. Both groups followed the instructions, they significantly reduced their self-reported total energy intake (specifically fat) when compared to baseline measurements. They also increased their activity scores significantly. Unfortunately, the four weeks intervention period was too short to see significant improvements in BMI or waist circumference. There were also no significant differences between the passive and proactive individuals in this experiment, which may lead to the conclusion that either personality does not play a role in the potential success of a diet-based intervention program or that the intervention was too short and too moderate to see significant changes.

Although we need to keep in mind that the data presented in this chapter, the data from the present study confirms that the personality of the individual may serve as a crucial factor predicting the relative success of an exercise-based weight loss intervention program. The result of the present study are remarkably similar to data from our previous experiments in rats, indicating that the rat studies could possibly be translated to the human population. This provides an opening for experiments in rats that focus on the underlying neurohormonal mechanisms in the central nervous system. The present studies also provided evidence for the existence of an endogenous mechanism that may regulate an individual's total activity on a day to day basis. This mechanism seems similar to the Activity Stat, proposed by the group of Wilkin (18;21).

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