Relationships between childhood environmental factors and adult pain perception

Doctoral (PhD) thesis

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1. Introduction

Although pain is an everyday phenomenon that we experience many times during our lives, its precise scientific description and definition is a seriously challenging task. This difficulty is well illustrated by the fact that the definition of pain was modified not so long ago by the International Association for the Study of Pain (IASP). According to the new definition, pain is "An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage." (Raja et al., 2020). Pain is always a personal experience that can be influenced by biological, psychological, and social factors, so it can only be understood from a bio-psycho-social perspective (Van Damme et al., 2010; Atlas & Wager, 2012; Raja et al., 2020)

Pain can negatively affect physical, emotional, and social functioning. It can cause emotional distress, anxiety, depression, hinder the fulfilment of personal, social, and professional roles, can reduce physical functioning, and can lead to physical limitations, disability (Niv & Kreitler, 2001; Katz, 2002). Pain interferes with task execution and performance by distracting attention from other activities (Crombez et al., 1998; Van Ryckeghem et al., 2012; Attridge et al., 2015). Due to the listed negative effects, it is extremely important to treat and reduce pain and ensure the patient's well-being, emphasizing not only the physical but also the subjective well-being (Niv & Kreitler, 2001). The goal is to effectively reduce symptoms and prevent pain from becoming chronic (Illés, 2015). It is not enough to treat pain only as a physical symptom, it is necessary to consider the biological, psychological and social background processes that may contribute to the individual differences in pain perception (Treede et al., 2015; Steingrímsdóttir et al., 2017; Raja et al., 2020). A better understanding of pain can therefore also contribute to the development of everyday clinical healing activities (de C Williams, 2016).

The purpose of our studies is to examine the cognitive factors that may play an important role in linking childhood environmental conditions and adult subjective pain. It can be assumed that childhood circumstances and experiences do not directly shape pain perception, but through many complex mechanisms, only a part of which is known and/or researched to date. A better understanding of these mechanisms can provide a deeper understanding of the processes involved in the development of pain perception, and they may point out new therapeutic opportunities. In the following chapters, we can gain insight into the importance of predictability and past-related attitudes; we can get to know their relationship with childhood environmental conditions and their relation to subjective pain in adulthood.

2. Aims and hypotheses

2.1. First study: <u>Pain catastrophizing and pain sensitivity are associated with early life environmental unpredictability: a path model approach</u>

In the first study, our main goal was to examine the associations of self-perceived pain sensitivity and catastrophizing with retrospectively measured childhood environmental conditions via the mediation of unpredictability and body awareness. We used a self-reported questionnaire, including multidimensional scales about the childhood environment, the Pain Catastrophizing Scale, the Pain Sensitivity Questionnaire, the Body Awareness Questionnaire and the Unpredictability Schema Questionnaire.

- We predicted that a higher extent of unpredictability emerging from socioeconomic disadvantages experienced in childhood (i.e., socioeconomic disadvantages, household unpredictability, and family resources) through the mediator role of body awareness can lead to higher pain catastrophizing and pain sensitivity. We performed Structural Equation Modeling to test the hypothesis.

2.2. Second study: <u>Fear of pain is associated with early life environmental unpredictability: a path model approach</u>

In the second study, based on the first study, we further examined the affective aspects of pain while examining pain-related fear. We examined how the unpredictability schema rooted in socioeconomic disadvantages is related to fear of pain.

- We tested the association of the unpredictability schema with fear of pain, along with the same predictions as in Study 1. For exploratory reasons we explored the predictions through a wider age range and controlling for depression to reduce the influence of the non-pain specific affective attitudes (i.e., depression) on the results.

2.3. Third study: <u>Negative time perspective predicts the self-perceived affective and physical components of pain independently from depression, anxiety, and early life circumstances</u>

In our third study, our goal was to examine the relationships between time-related attitudes (time perspectives) and adult pain perception, considering childhood environmental factors and negative affectivity. We tested the relationships between the Zimbardo Time Perspective Questionnaire, pain catastrophizing, pain sensitivity, and fear of pain; we also measured various childhood environmental factors (socioeconomic status, household unpredictability and family resources) retrospectively. The models were controlled for depression and anxiety.

- We investigated the assumption that past-negative time perspective is associated with the negative evaluation of pain, which is reflected in higher levels of pain sensitivity, pain catastrophizing and fear of pain.
- In addition, we hypothesized that although depression and anxiety can be related to time perspective and to the pain variables, we examined, past-negative time perspective will be independently related to the pain variables.

We tested the hypotheses using hierarchical and linear regression models. In addition, based on the results of the regression analyses, we also tested a Structural Equation Model, to examine whether the past-negative time perspective mediates the effect of family unpredictability on the emotional and physical evaluation of pain in adulthood.

2.4. Fourth study: <u>Negative attitude toward the past is associated with catastrophized fatigue and pain in the present</u>

In the fourth study, we examined whether time perspectives are specifically related to pain catastrophizing, or is it also related to other catastrophizing tendencies. This question emerged from the findings of previous studies, which drew attention to the hypothesis that a general catastrophizing tendency exists, that predisposes individuals to negatively evaluate and ruminate on various situations (Pike et al., 2021). In this study, we examined this question by testing the relationship between pain catastrophizing, fatigue catastrophizing and time perspectives. Fatigue catastrophizing has been investigated in very few studies before; despite the fact that fatigue catastrophizing can have potentially (even serious) negative consequences.

- We assumed a positive association between pain and fatigue catastrophizing. Second, we predicted that individuals with a more negative attitude toward the past tend to catastrophize the symptoms of fatigue.
- Pain catastrophizing – TP relationships were also explored to examine the potential similarities and differences between pain and fatigue catastrophizing in their associations with TPs.

The questions of the study were examined with a cross-sectional, questionnaire methodology; regression analyses and cluster analysis were performed.

3. First study: Pain catastrophizing and pain sensitivity are associated with early life environmental unpredictability: a path model approach

3.1. Methods

3.1.1. Participants

In the first study, 252 healthy, pain-free individuals participated (176 women and 76 men; aged between 18 and 35 years, mean age = 24.6 years, standard deviation = 4.72 years). The sample size of the study was sufficient to provide the appropriate statistical power based on the results of the semPower function (N = 164$_{first model}$ and N = 160$_{second model}$). The participants were unaware of the purposes and hypotheses of the study. They reported pain-free health conditions, that is, they had no current pain or history of any chronic illness associated with pain. The study was conducted according to the principles of the Declaration of Helsinki and was approved by the Ethical Committee of the University of Pécs.

3.1.2. Questionnaires

Childhood environmental factors. Childhood environmental conditions were examined retrospectively using three questionnaires:

- A three-item questionnaire about the childhood socioeconomic status (e.g. "I felt relatively wealthy compared to other kids at my school."). Higher score indicates higher socioeconomic status (SES), rated on a seven-point Likert scale. (Griskevicius et al., 2011). McDonald's omega (ω) = .77.
- An eight-item questionnaire about the material and non-material resources available to the family during childhood (attention, care, discipline, clothing, food, etc.) (McDonald's ω = .88). Assessed on a five-point Likert scale, higher score indicates more resources (Rindfleisch et al., 1997).
- A three-item questionnaire about the predictability of the childhood family (household unpredictability), (e.g. "Things were often chaotic in my house."). Higher score (measured on a seven-point Likert scale) indicates higher level of unpredictability experienced in the household (Mittal et al., 2015). Due to the low variance in the responses, the first item ("Quite often, quite randomly, different people moved in and out of our home") was excluded from further analysis.

Unpredictability schema. The unpredictability schema was examined with the 7-item questionnaire (USQ) developed by Cabeza de Baca et al. (2016) (McDonald's ω = .63). Each item was rated on a dichotomous scale (0: True, 1: False). The questionnaire was created by adapting other well-known and widely used questionnaires: selecting the items that cover the issues of interpersonal trust, self-efficacy, and locus of control, general uncertainty and unpredictability ("I have a good idea about what is going to happen in my life", "I give up easily".) (Cabeza de Baca & Albert, 2019; Proffitt Leyva & Hill, 2018). We adapted the original scale to the Hungarian language. When creating the Hungarian version, the original English questionnaire was translated into Hungarian by two distinct people as a first step. After checking and comparing the two translations, a third person

translated back to English. We also discussed and coordinated the translation with the original author (T. Cabeza de Baca).

Body awareness. To examine body awareness, we used the Body Awareness Questionnaire (McDonald's ω = .83) (BAQ; Shields et al., 1989; Köteles, 2014). The Hungarian version of BAQ contains 17 items (e.g., "I notice differences in the way my body reacts to various foods", "I can tell when I go to bed how well I will sleep that night.")

Pain variables. *Pain catastrophizing* was examined using the Pain Catastrophizing Scale (PCS). The PCS (Quartana, et al., 2009; Kökönyei, 2008) is a 13-item questionnaire. It measures pain perception by focusing on the different perspectives of catastrophizing: Rumination (constant negative thoughts about pain; e.g. "I keep thinking about how much it hurts."), Magnification (exaggeration of pain, e.g. "I wonder whether something serious may happen") and Helplessness (feeling the inability to cope with pain, e.g. I feel I can't go on."). It is evaluated on a five-point Likert-type scale. A higher score indicates a greater tendency towards pain catastrophizing. (Mcdonald's $\omega_{rumination}$ = .88, $\omega_{magnification}$ = .78, $\omega_{helplessness}$ = .87). *Pain sensitivity* was examined using the Pain Sensitivity Questionnaire (PSQ). The PSQ (McDonald's ω = .93) consists of 13 items and measures the subjective experience of pain intensity and sensitivity to pain in everyday situations, in relation to everyday accidents. A higher mean score indicates higher pain sensitivity (e.g., "Imagine you burn your tongue on a very hot drink.") (Ruscheweyh et al., 2009, Gács, 2019).

3.1.3. Procedure

The participants answered on an anonymous online questionnaire package. They could start completing the questionnaires after providing informed consent. The data was collected using Google's questionnaire services (Google Forms, Google Docs). We recruited people through online advertisements, mainly with the help of social media. Participants were unaware of the purposes and hypotheses of the study.

3.1.4. Data analysis

The analysis began with descriptive statistics and (Spearman's) correlation coefficients. The predictions were tested with Structural Equation Modeling. Two separate models were constructed for pain sensitivity and pain catastrophizing. The models were constructed based on Proffit Leyva and Hill's (2018) research. Each model constituted a path from childhood socioeconomic status and household unpredictability to one of the pain variables (i.e., pain catastrophizing or pain sensitivity) via the intermediate factors of family resources, unpredictability schema and body awareness. The models were also controlled for gender based on statistical considerations and previous studies showing gender differences in both pain sensitivity and pain catastrophizing (Hashmi and Davis, 2014; Pieretti et al., 2016; Ostrom et al., 2017). The two genders were found to be significantly different in each scale of catastrophizing: women scored higher than men on the rumination $(t(250) = 2.86, p < .01)$, magnification $(t(250) = 2.06, p < .05)$, and helplessness $(t(250) = 2.78, p < .01)$ subscales of the PCS. In the case of the PSQ, no significant gender difference was found, but for a better comparison of the two models,

and nd to take the findings of previous studies into account, this model was also controlled for gender.

Structural Equation Modeling was performed using the JASP statistical software (Windows version .14.1), which utilizes the lavaan package of the R programming language to calculate the fit indices of the hypothesized models (Rosseel, 2012). We used the diagonally weighted least squares (DWLS) estimator, as this estimation method provides more accurate parameter estimates and a more robust model fit even in cases where the variables are ordinal and/or there are deviations from the normal distribution (Mîndrilã, 2010; Forero et al., 2009). To evaluate model fit, we used the relative chi-square (χ^2/df), <3 comparative fit index (CFI) , Tucker–Lewis index (TLI) and root mean square error of approximation (RMSEA). The cut offs for good model fit were relative chi-square < 3 (Kline, 1998), CFI and TLI values of .95 or greater (Hu & Bentler, 1998), and RMSEA values of .08 or lower (Browne & Cudeck , 1993).

3.2. Results

First model: pain sensitivity.

The first model (pain sensitivity, see Figure 1) constituted a path from childhood socioeconomic status and childhood household unpredictability, to pain sensitivity via the factors of family resources, unpredictability schema and body awareness. The test showed good model fit (χ^2/df = 2.089, CFI = .958, TLI = .957, RMSEA = .066, 90%CI = [.062–.069]). In accordance with our hypothesis, we found that socioeconomic status predicted family resources (β = .42, p < .001) and family unpredictability (β = -.61, p < .001). Family resources had a negative relationship with the unpredictability schema (β = -.43, p < .001), which showed a negative relationship with body awareness (β = -.21, p < .001). Finally, body awareness predicted pain sensitivity (β = -.15, p < .001) and showed a significant relationship with gender (β = .08, p < .01). Based on theoretical considerations, we allowed covariances between socioeconomic status and household unpredictability (β = -.28, p < .001).

In addition, we introduced covariances between certain items based on the modification indices (MI): BAQ2 and BAQ3 (MI = 46.65), BAQ1 and BAQ4 (MI = 44.73), BAQ14 and BAQ16 (MI = 4.63), FR1 and FR3 (MI = 35.16), FR2 and FR3 (MI = 28.38). The introduced covariances improved the model fit. In summary, consistent with our hypothesis, we found that individuals experiencing adverse early life circumstances showed greater pain sensitivity and that this relationship was mediated by unpredictability schema and body awareness.
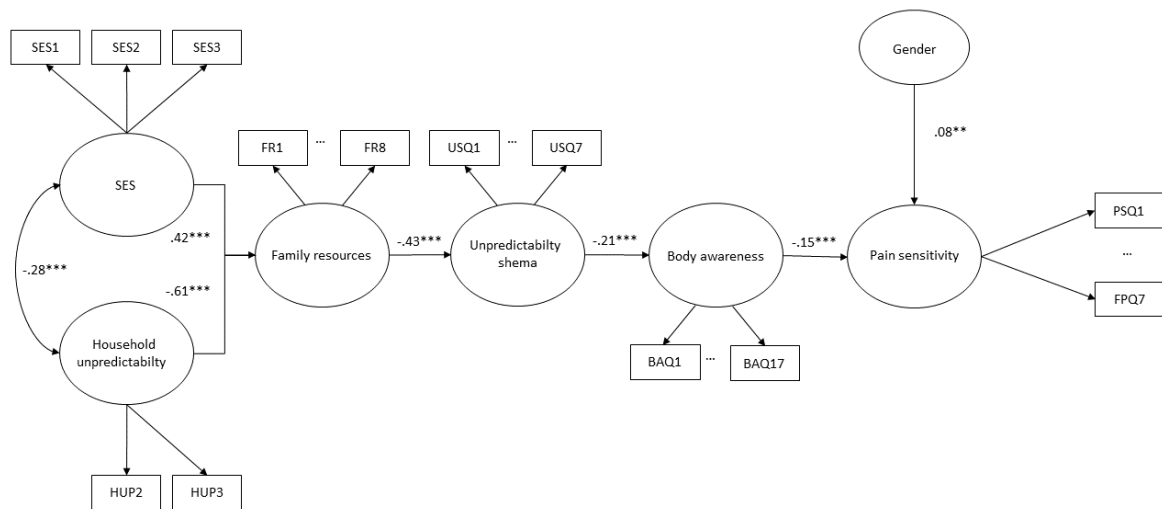
Figure 1. The first model of Study 1 from childhood socioeconomic status and household unpredictability to pain sensitivity through the mediating factors of family resources, unpredictability schema, and body awareness. All indicated estimates are maximum likelihood standardized point-estimates. (Notes: *p <.05; **p <.01, ***p <.001. For clarity reasons, by questionnaires with a large number of items, items were marked with "..." on the figure.

Second model: pain catastrophizing.

The second model (pain catastrophizing, see Figure 2), constituted a path from childhood socioeconomic status and childhood household unpredictability, to the three subscales of pain catastrophizing: rumination, magnification, and helplessness via the factors of family resources, unpredictability schema and body awareness.

The test again showed good model fit ($\chi2/df = 2.385$, CFI = .952, TLI = .952, RMSEA = .074, 90%CI = [.071–.078]). Socioeconomic status predicted family resources ($\beta = .42$, $p < .001$), and childhood household unpredictability ($\beta = -.6$, $p < .001$). Family resources was associated with the unpredictability schema ($\beta = -.4$, $p < .001$). The unpredictability schema predicted body awareness ($\beta = -.31$, $p < .001$). Finally, body awareness predicted all three PCS subscales: rumination ($\beta = -.2$, $p < .001$), magnification ($\beta = -.18$, $p < .001$) and helplessness ($\beta = -.19$, $p < .001$). Gender showed a relationship with all three PCS subscales: rumination ($\beta = -.18$, $p <.001$), magnification ($\beta = -.12$, $p < .05$) and helplessness ($\beta = -.19$, $p < .001$).

Again, we allowed covariances between socioeconomic status and family predictability ($\beta = -.28$, $p < .001$): between PCS rumination and PCS magnification ($\beta = .79$, $p < .001$); between PCS rumination and PCS helplessness ($\beta = .88$, $p < .001$); and between PCS magnification and PCS helplessness ($\beta = .86$, $p < .001$). In addition, we allowed covariances based on the modification indices: BAQ2 and BAQ3 (MI = 48.33); BAQ1 and BAQ4 (MI = 46.18); BAQ14 and BAQ16 (MI = 38.71); FR1 and FR3

(MI=36.04); and between items FR2 and FR3 (MI = 29.09). The introduced covariances improved the model fit.

Our result supported the hypothesis that negative early life environmental factors can contribute to pain catastrophizing in adulthood, and this relationship is mediated by the unpredictability schema and body awareness.
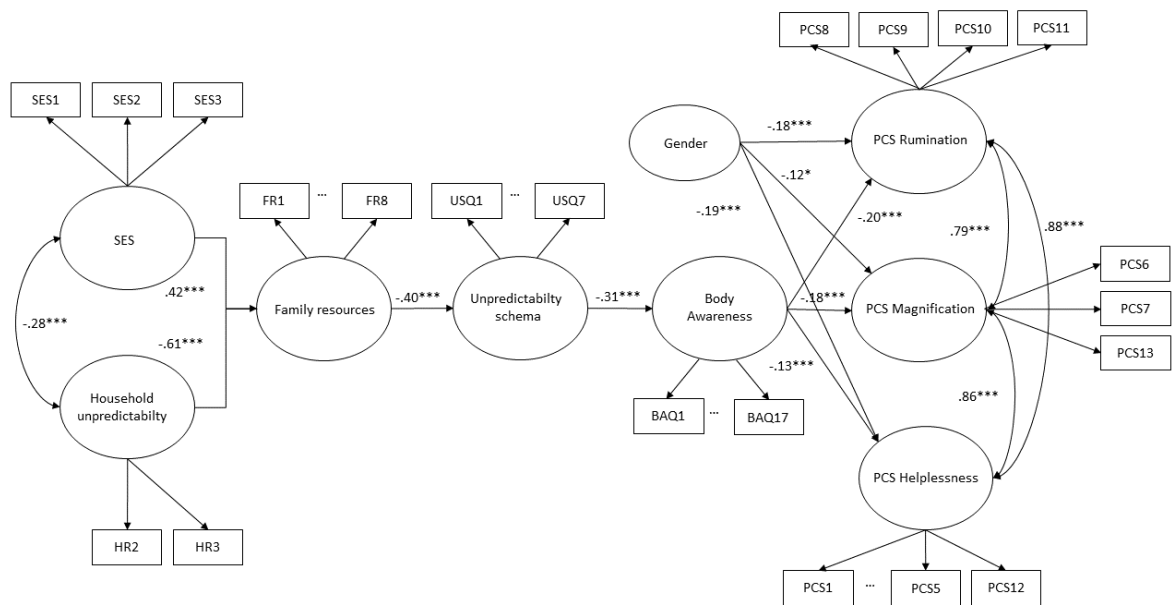

Figure 2. The first model of Study 1 from childhood socioeconomic status and household unpredictability to pain catastrophizing subscales through the intermediate factors of family resources, unpredictability schema, and body awareness. All indicated estimates are maximum likelihood standardized point-estimates. (Notes: *p <.05; **p <.01, ***p <.001. For clarity reasons, by questionnaires with a large number of items, items were marked with "..." on the figure.

4. Second study: Fear of pain is associated with early life environmental unpredictability: a path model approach

4.1. Methods

4.1.1. Participants

293 individuals participated in the second study (243 women and 50 men; age: 18 - 72 years, mean = 24.6 years, SD = 4.72 years). The sample size of the study was sufficient to provide the appropriate statistical power based on to the results of the semPower function (N >= 147). Only those who did not report acute or chronic pain or associated illness could participate in the study. The research was conducted in accordance with the Declaration of Helsinki and was approved by the Ethical Committee of the University of Pécs.

4.1.2. Questionnaires

The participants responded to the same multidimensional measures about their childhood conditions as in Study 1. That is, they completed the measures of childhood socioeconomic status (McDonald's ω = .82) (Griskevicius et al., 2011), family resources (McDonald's ω = .89) (Rindfleisch et al., 1997.) and childhood household unpredictability (McDonald's ω = .66) (Mittal et al., 2015). In addition, we again assessed the unpredictability schema with the Unpredictability Schema Questionnaire (McDonald's ω = .67) (Cabeza de Baca et al., 2016). Body awareness was assessed with the Body Awareness Questionnaire (BAQ-H; McDonald's ω = .84) (Köteles et al., 2014). Last, participants answered the 9-item Fear of Pain Questionnaire-9 (FPQ; McDonald's ω = .79). The FPQ measures individuals' fear of pain by focusing on the different types of pain-related fear: fear of severe pain (e.g., "Falling down a flight of concrete stairs"), fear of minor Pain (e.g., "Gulping a hot drink before it has cooled") and fear of medical pain (e.g., "Receiving an injection in your hip/buttocks") (McNeil et al., 2018). To screen for symptoms of tdepression, we used the 9-item short form of the Beck Depression Inventory (BDI; McDonald's ω = .83) (Rózsa et al., 2001).

4.1.3. Data analysis

The data analysis was identical to that described for Study 1. The model constituted a path from childhood socioeconomic status and household unpredictability to fear of pain via the factors of family resources, unpredictability schema and body awareness. Based on Spearman correlation coefficients ($r \geq .25$), depression was used as a control for the unpredictability schema, household unpredictability and family resources. Age was not included as a control variable in the model based on the Spearman correlation coefficients. In addition, the model was repeatedly controlled for gender for comparisons with the models of Study 1.

4.2. Results

The test showed a good model fit ($\chi2/df = 1.315$, CFI = .951, TLI = .95. RMSEA = .057, 90%CI = [.054–.060]). Both socioeconomic status (β = .54, p < .001) and family

unpredictability ($\beta = -.43$, $p < .001$) showed a significant negative relationship with family resources. Family resources predicted the unpredictability schema ($\beta = -.31$, $p < .001$). The unpredictability schema showed a significant negative association with body awareness ($\beta = -.44$, $p < .001$). Finally, body awareness had a significant negative relationship with all three fear of pain subscales: fear of severe pain ($\beta = -.14$, $p < .001$), fear of minor pain ($\beta = -.20$, $p < .001$) and fear of medical pain ($\beta = -.35$, $p < .001$). Depression associated with family unpredictability ($\beta = .42$, $p < .001$) and unpredictability schema ($\beta = .62$, $p < .001$), but with family resources ($\beta = .01$, *n.s.*). Gender was only associated with fear of severe pain ($\beta = -.14$, $p < .01$).

We allowed covariances between socioeconomic status and Family Unpredictability ($\beta = -.36$, $p < .001$); between FPQ severe pain and FPQ minor ($\beta = .72$, $p < .001$); between FPQ severe pain and FPQ medical pain ($\beta = .57$, $p < .001$); and between FPQ minor and FPQ medical pain ($\beta = .56$, $p < .001$). Furthermore, based on the modification indices, BAQ14 and BAQ16 (MI = 51.39), BAQ2 and BAQ3 (MI = 41.09), BAQ8 and BAQ9 (MI = 39.22), FR2 and FR3 (MI = 46.31), between FR4 and FR7 (MI = 44.13), for better model fit.

In summary, as hypothesized, we found that individuals with negative early life environmental factors experienced more fear from different types of pain (including severe, minor, and medical pain), and this relationship was mediated by unpredictability schema and body awareness.
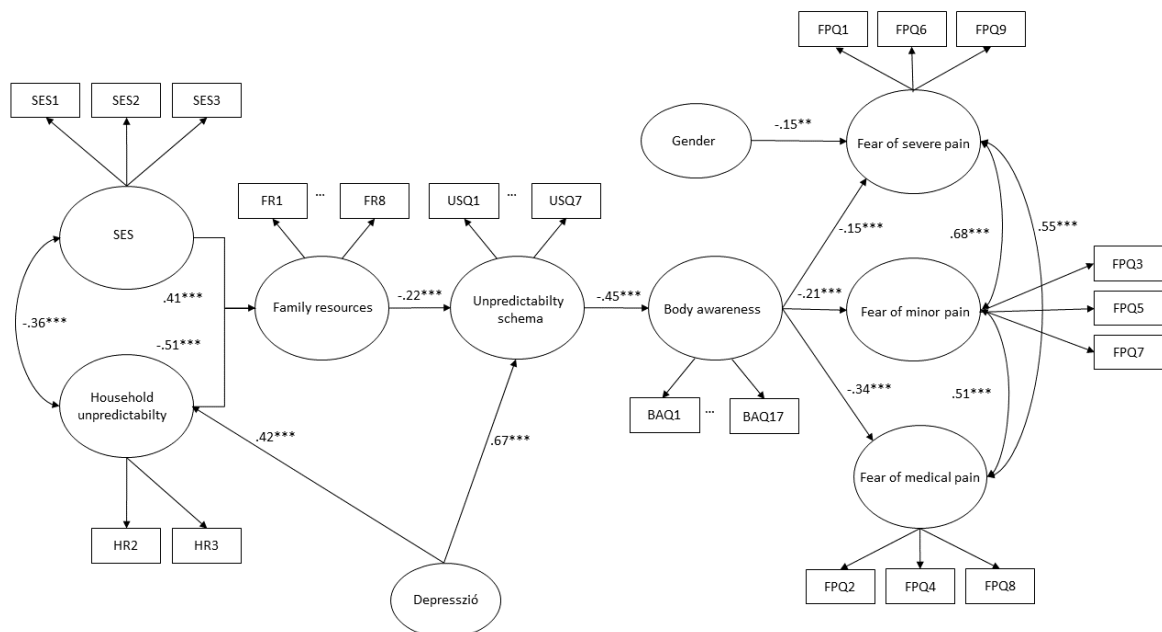

Figure 3. The first model of Study 1 from childhood socioeconomic status and household unpredictability to pain catastrophizing subscales through the intermediate factors of family resources, unpredictability schema, and body awareness. All indicated estimates are maximum likelihood standardized point-estimates. (Notes: *p <.05; **p <.01, ***p <.001. For clarity reasons, by questionnaires with a large number of items, items were marked with "..." on the figure.

5. Third study:

5.1. Methods

5.1.1. Participants

353 individuals participated in the study, (270 women and 83 men). The mean age of the participants was 35.20 years (SD = 12.12 years; ranged from 18 to 67 years). The preliminary sample size was determined using G*Power 3.1 software (Faul et al., 2009). For multiple regression, the minimum number required was 184 participants. The required estimated sample size for the correlation analysis was 138 participants. In addition, referring to the tested SEM models, the semPower function (R) indicated a minimum sample size of 255 people. Overall, based on the calculations, the sample size of the present study was sufficient to detect significant effects for regression, correlation and SEM analyses. The research was conducted in accordance with the rules of the Declaration of Helsinki and was approved by the Ethical Committee of the University of Pécs.

5.1.2. Questionnaires

Childhood environmental factors. The questionnaires used to assess childhood environmental factors were the same as those used in the previous studies: the three-item questionnaire on childhood socioeconomic status (Griskevicius et al., 2011; McDonald's ω = .84); family Resources questionnaire (Rindfleisch et al., 1997; McDonald's ω = .90); and the childhood household unpredictability questionnaire (Mittal et al., 2015; McDonald's ω = .71).

Time perspectives. The different time perspectives were examined using the 56-item Zimbardo Time Perspective Questionnaire (ZTPI; Zimbardo & Boyd, 2015). It is rated on a five-point Likert scale. The subscales of the questionnaire are as follows:

- Past-negative time perspective, which indicates a tendency to recall bad memories from the past and having an overall negative attitude toward past experiences (e.g. "I often think of what I should have done differently in my life.") (McDonald's ω = .86);
- Past-positive time perspective, indicating a tendency to recall good and pleasant memories from the past and having an overall positive attitude toward past experiences. (e.g. "Familiar childhood sights, sounds, smells often bring back a flood of wonderful memories.") (McDonald's ω = .83);
- Present-fatalistic time perspective, which indicates the belief that life is determined by fate and destiny, implying a lack of self-efficacy and proactivity (e.g. "My decisions are mostly influenced by people and things around me.") (McDonald's ω = .72)
- Present-hedonistic time perspective, which indicates a tendency to behave under the influence of the present moment, enjoying and searching for immediate pleasure and gratification. (e.g. "I believe that getting together with one's friends to party is one of life's important pleasures.") (McDonald's ω = .78);

- Future time perspective, indicating future orientation, the dominance of focusing on future events and goals (e.g. "I believe that a person's day should be planned ahead each morning.") (McDonald's ω = .72).

Depression. Depressive tendencies and symptoms were again monitored with the 9-item Beck Depression Questionnaire (Rózsa et al., 2001; McDonald's ω = .80).

Anxiety. State and trait anxiety were examined with the short version of Spielberger's State-Trait Anxiety Questionnaire (STAI), consisting of five-five items, rated on a 4-point Likert-scale. The state subscale addresses the current anxiety level (e.g. "I feel upset"; McDonald's ω = .92); the trait subscale indicates the general anxiety level (e.g. "I take disappointments so keenly that I can't put them out of my mind."; McDonald's ω = .88). Higher scores indicate higher state and trait anxiety, respectively.

5.1.3. Data analysis

Multiple linear regression analysis was performed to test the relationship of depression, anxiety and early life circumstances with time perspectives. Hierarchical regression analysis was uperformed to examine the relationship between time perspectives and pain variables, analyzing pain sensitivity, pain catastrophizing, and fear of pain separately. Finally, we used Structural Equation Modeling to investigate the mediating role of time perspectives between early life circumstances and pain variables. We tested three SEM models. Each model constituted a path from childhood family unpredictability to the pain variables through past-negative time perspective (based on the results of the regressions). In the models, gender, depression and trait anxiety were included as controls, due to their close correlation with the past-negative time perspective.

5.2. Results

5.2.1. Regression analysis for the association of time perspectives with depression, anxiety, and the early life conditions

Multiple linear regression analysis was used to explore the relationship between time perspectives and childhood variables, as well as depression and anxiety. Each TP was separately regressed on the six predictors (depression, state anxiety, trait anxiety, socioeconomic status, childhood household unpredictability, family resources). Greater depression and trait anxiety were associated with higher past-negative and present-fatalistic time perspective scores. In line with this finding, the opposite trend of association was observed for past-positive time perspective: higher scores of depression and state anxiety predicted a less positive perception of the past. An interesting result is that depression and trait anxiety have a different relationship with future orientation. While higher depression was associated with lower future orientation, high trait anxiety predicted a greater future-oriented time perspective.

Of the early life conditions, socioeconomic status had a significant positive relationship with present-hedonism, which suggests that a higher level of socioeconomic status experienced in childhood may be related with an increased present- and reward-oriented attitude. Both household unpredictability and family resources significantly and

independently predicted time perspectives. Individuals who reported an unpredictable household environment scored higher on past-negative time perspective and had lower scores on past-positive time perspective. Similarly, more family resources predicted a more positive evaluation of the past (i.e., a higher score on the past-positive time perspective scale).

In summary, depression and trait anxiety, as well as childhood environmental conditions, were independently and significantly associated with certain time perspective subscales. In the following, we therefore also examined the extent to which these variables can influence and modify the time perspective-pain relationship. Multivariate hierarchical regression analyzes were performed to learn the relationship between time perspectives and pain variables.

5.2.2. Regression analyses for the association of the time perspectives and the pain catastrophizing

Hierarchical regression analysis was performed to examine the relationship between time perspectives and pain sensitivity measured by the PSQ. For the analysis of the two subscales of the PSQ (moderate and minor), we performed separate analyses, as follows: in the first model (model I), time Perspectives and gender were included as predictors. In the second model (model II.), we included childhood environmental variables (socioeconomic status, household unpredictability, and family resources), depression, and state and trait anxiety scales. Multicollinearity was not a concern in the models (VIF values were below 4).

The analysis showed that past-negative time perspective was a significant independent predictor of minor and moderate pain sensitivity. The explained variance did not show a significant change from model I to model II. model on any scale of the PSQ. That is, none of the ΔF values reached significance, indicating that adding depression, anxiety, and childhood environmental factors to the models did not change model fit. Depression and anxiety were not significant predictors of pain sensitivity. Among childhood environmental variables, only socioeconomic status predicted significantly minor pain sensitivity: higher socioeconomic status was associated with higher pain sensitivity in the case of minor pain.

In summary, according to the hypothesis, pain sensitivity, as a physical component of pain, independently predicted by the past-negative time perspective. Depression, anxiety, and childhood environmental factors did not predict pain sensitivity.

5.2.3. Regression analyses for the association of the time perspectives and the pain catastrophizing

Multivariate hierarchical regression analysis was performed to examine the relationship between time perspectives and pain catastrophizing measured by the PCS. Each scale of pain catastrophizing (rumination, magnification, and helplessness) was regressed separately on the two models as follows: in the first model (model I), time perspectives and gender were included as predictors. In the second model (model II), we added childhood environmental variables (socioeconomic status, family unpredictability, and

family resources), depression, and state and trait anxiety scales. Multicollinearity was not a concern in the models.

In model I, past-negative time perspective, present-fatalism and pain catastrophizing showed a significant relationship. Past-negative time perspective was a significant positive predictor of rumination, magnification, and helplessness. In addition, higher present-fatalism scores were associated with higher magnification and helplessness scores.

As a next step, socioeconomic status, family unpredictability and family resources, as well as depression, state anxiety and trait anxiety variables were included in the model (model II.). The addition of the new variables led to a moderate increase in the variance explained by the model, reaching significance levels on the PCS magnification and helplessness scales, indicated by the significant ΔF. In this model, past-negative time perspective remained a significant independent predictor of rumination and helplessness (although the strength of the association was lower). On the other hand, present-fatalism no longer predicted magnification and helplessness. We found two significant associations between childhood environment and pain catastrophizing: higher household unpredictability was associated with higher magnification and helplessness scores. Higher trait anxiety and state anxiety were also associated with significantly higher magnification. Depression was not significantly related to any of the catastrophizing subscales.

In summary, supporting the hypothesis, past-positive time perspective remained an independent, significant predictor of rumination and helplessness, even after the introduction of childhood environmental variables and anxiety and depression.

5.2.4. Regression analyses for the association between the time perspectives and the fear of pain

Multivariate hierarchical regression analyzes were performed to examine the relationships between time perspectives and fear of pain. To analyze the three subscales of the FPQ (fear of severe pain, fear of minor pain, and fear of medical pain), we performed the tests separately, similarly to pain sensitivity and pain catastrophizing: in the first model (model I), time perspectives and gender were included as predictors. In the second model (model II), we added childhood environmental factors, depression, and state and trait anxiety scales to the model. As in the other models, multicollinearity was not a concern in the models (VIF values were below 4).

The analysis showed that in model I, past-negative time perspective was a significant predictor of all three subscales of fear of pain. Fear of medical pain was also predicted by present-fatalism. In model II., when depression, anxiety and childhood environmental variables were added to the model, past-negative time perspective only remained a predictor of fear of severe pain. These results supported the hypothesis, at least for the severe pain subscale of the FPQ, that past-negative time perspective remained an independent predictor of fear of pain. Fear of severe pain was also significantly predicted by trait anxiety, which suggests that individuals with higher trait anxiety tend to have more negative attitudes toward past experiences. The significant relationship

between fear of minor pain and fear of medical pain with past-negative time perspective was observed only in model I. When additional variables were entered into the model, depression became the only independent predictor of fear of medical pain; higher depression scores were associated with greater fear of medical pain. None of the childhood environmental variables significantly predicted participants' fear of pain.

5.2.5. Structural equation models: time perspective as a mediator between early life conditions and pain

Based on the results of the regression analyses, a mediator role of time perspectives between early life conditions and the pain variables seems plausible: we found that among the childhood life circumstances, family unpredictability predicted the past-negative time perspective, which predicted many pain variables tested in this study. To investigate whether past-negative time perspective really mediates the relationship between family unpredictability and pain, we tested three SEM models (Figure 4). Each model constituted a path was from household unpredictability to the different pain variables via the past-negative time perspective. We included the pain variables that were related to the past-negative time perspective based on the results of the regression analyses. Gender, as well as depression and trait anxiety, were introduced into the models as controls due to strong associations with past-negative time perspective. The first model ended on minor and moderate pain sensitivity, the second on PCS rumination and PCS helplessness, and the third model ended on fear of severe pain and fear of minor pain. The models showed a good fit:

- **Model I. (pain sensitivity):** $\chi 2/df = 1.893$, CFI = .983, TLI = .983, RMSEA = .05. 90% CI = [.047–.054], $R^2_{minor\ pain} = .084$, $R^2_{moderate\ pain} = .032$
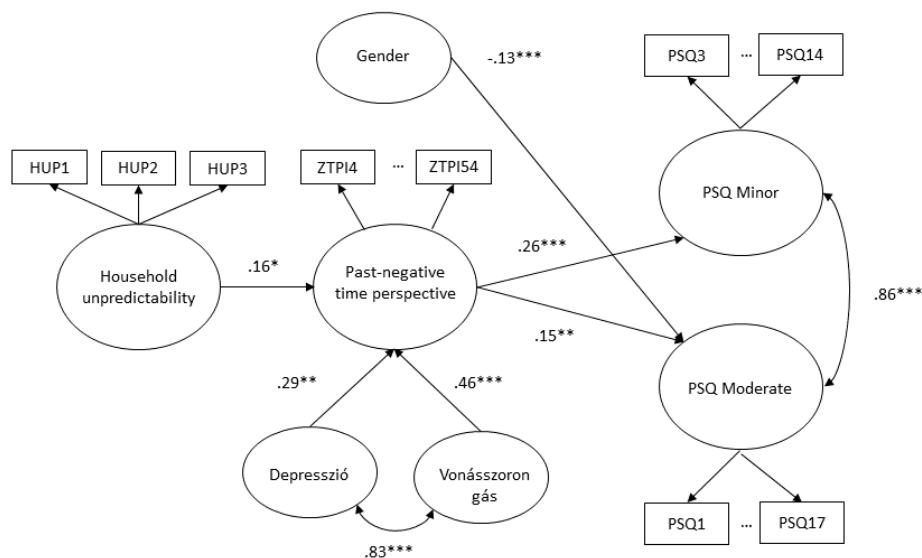

Figure 4. Path model from household unpredictability to the pain sensitivity subscales. All indicated estimates are maximum likelihood standardized point-estimates. (Notes: *p <.05; **p <.01, ***p <.001. For clarity reasons, by questionnaires with a large number of items, items were marked with "..." on the figure.

- **Model II. (pain catastrophizing):** $\chi^2/df = 1.878$, CFI = .986, TLI = .986, RMSEA = .050; 90% CI = [.046–.054], $R^2_{rumination}$ = .184, $R^2_{helplessness}$ = .275
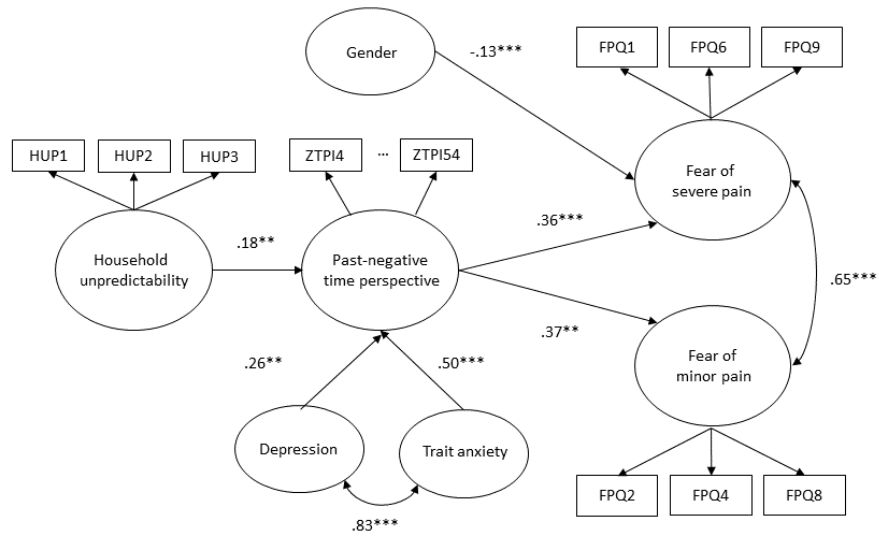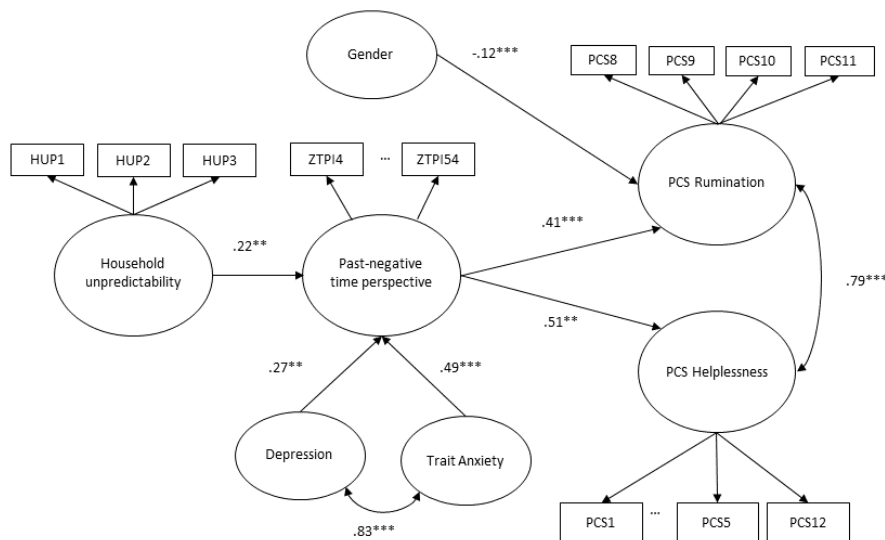

Figure 5. Path model from household unpredictability to the fear of pain subscales. All indicated estimates are maximum likelihood standardized point-estimates. (Notes: $*p < .05$; $**p < .01$, $***p < .001$. For clarity reasons, by questionnaires with a large number of items, items were marked with "..." on the figure.

- **Model III. (fear of pain):** $\chi^2/df = 2.085$, CFI = .979, TLI = .979, RMSEA = .056, 90% CI = [.051–.060], R^2fear of severe pain = .141, R^2fear of minor pain = .158.

Figure 4. Path model from household unpredictability to the pain sensitivity subscales. All indicated estimates are maximum likelihood standardized point-estimates. (Notes: $*p < .05$; $**p < .01$, $***p < .001$. For clarity reasons, by questionnaires with a large number of items, items were marked with "..." on the figure.

In each model, higher household unpredictability associated with higher past-negative time perspective, leading to increased pain sensitivity in Model I., increased pain catastrophizing in Model II, and increased fear of pain in Model III. Gender was associated with PSQ minor pain and PSQ moderate pain, PCS rumination and PCS helplessness, and fear of severe pain. In summary, the results of SEM models showed that past-negative time perspective is significantly related to different pain variables, and supported the assumption that past-negative time perspective has a mediating role between childhood environment and adult self-perceived pain.

6. Negative attitude toward the past is associated with catastrophized fatigue and pain in the present

6.1. Methods

6.1.1. Participants

305 participants (women = 224) aged between 18 and 67 years (mean = 42.24, SD = 16.66, range: 18-80 years) participated in the study. The minimum sample size required was 172 participants according to the power analysis (G*Power 3.1). Participants had no current pain or history of any chronic illness associated with pain. They completed an anonymous online survey and provided online consent. The study was conducted according to the principles of the Declaration of Helsinki and approved Ethical Committee of the University of Pécs.

6.1.2. Questionnaires

Time perspectives. Time perspectives were measured with the 56-item ZTPI (Zimbardo & Boyd, 2015). McDonald's $\omega_{past-negative}$= .88; McDonald's $\omega_{past-positive}$ = .86; McDonald's $\omega_{present-fatalistic}$ = .80; McDonald's $\omega_{present-hedonistic}$ = .71; McDonald's ω_{future} = .75.
Fatigue catastrophizing. To measure fatigue catastrophizing we used a Hungarian translation of the Fatigue Catastrophizing Scale (FCS; Jacobsen et al., 2004). The FCS is a self-rating questionnaire with 10 items, referring to different thoughts people have when they experience fatigue (e.g. "I imagine the fatigue becoming even more intense and exhausting"), rated on a five-point Likert-type scale (McDonald's ω = .92).
Pain catastrophizing. Pain catastrophizing was measured with the 13-item Pain Catastrophizing Scale (PCS; Sullivan et al, 1995; McDonald's $\omega_{rumination}$ = .87, $\omega_{fmagnification}$= .81, $\omega_{thelplessness}$ = .90).
State and trait anxiety. To measure state and trait anxiety, we used the five-item brief version of the State-Trait Anxiety Inventory (STAI) (Zsido et al., 2020; McDonald's ω_{state} = .91; McDonald's ω_{trait} = .87).
Depression. The nine-item short form of the Beck Depression Inventory was used to screen depression symptoms (Beck & Beck., 1972; McDonald's ω = .86).

6.1.3. Data analysis

To explore the relationships between pain catastrophizing and fatigue catastrophizing, and to examine the relationships between time perspectives and different catastrophizing tendencies, we used multiple linear regression analysis. In addition, we used the person-oriented approach proposed by Boniwell et al. (2010) to identify groups of participants with different time perspective profiles (cluster-analysis). Finally, Kruskal-Wallis post-hoc pairwise comparisons (with Bonferroni correction) were performed to compare clusters based on their pain and fatigue catastrophizing characteristics.

6.2. Results

FCS had positive, significant correlations with the three scales of PCS (PCS$_{rumination}$: r = .48, p < .001; PCS$_{magnification}$: r = .56, p < .001; PCS$_{helplessness}$: r = .61, p < .001). However,

a multiple regression model revealed that only the helplessness subscale ($\beta = .21$, t = 3.39, $p < .001$), as well as depression ($\beta = .32$, t = 6.29, $p < .001$), and anxiety (State: $\beta = .12$, t = 2.48, $p = .01$; Trait: $\beta = .24$, t = 4.31, $p < .001$) were significant independent predictors of FCS when it was regressed on the three PCS scales as well as on participants' depression, anxiety, age, and gender.

Regression analyses were also performed to examine the predictability of TPs on FCS and PCS: the variables of FCS and PCS were separately regressed on the predictors of TPs as well as depression, anxiety, age, and gender. These analyses revealed that of the five TPs only past-negative TP was associated with FCS and PCS (see Table 1). Individuals with higher past-negative reported a more catastrophizing attitude toward both pain and fatigue. Fatigue and pain catastrophizing were also similar in respect of the effect of the control variables: individuals scoring high on depression and trait anxiety catastrophized both fatigue and pain.

In addition, we assessed a person-oriented approach suggested by Boniwell, Osin, Alex Linley, and Ivanchenko (2010) to identify groups of participants with different TP profile. Specifically, a hierarchical cluster analysis was performed (four-cluster result, Ward's method and the Euclidean squared metric) to determine groups of participants with similar TP profiles in the present sample.

The cluster analysis showed that the clusters were different both in terms of fatigue and pain catastrophizing:

- FCS: H(3) = 88.37, $p < .001$;
- PCSrumination: H(3) = 35.14, $p < .001$;
- PCSmagnification: H(3) = 38.97, $p < .001$;
- PCShelplessness: H(3) = 49.73, *n.s*).

We performed Bonferroni corrected post-hoc pairwise comparisons to examine cluster differences in pain and fatigue catastrophizing. The post-hoc analysis showed that individuals belonging to the Cluster 2 significantly had the highest fatigue and pain catastrophizing attitudes compared to individuals in the other Clusters ($p < .001$). Cluster 4 was yielded to be the second cluster where individuals were characterised by high fatigue and pain catastrophizing. Cluster 2 was dominated by a high level of present-fatalism and past-negative attitudes. In Cluster 4, past-negative TP was the only dominant character.

7. General discussion

Pain perception is a complex process, influenced by numerous pain mechanisms. Understanding these mechanisms is extremely important in pain-related scientific research and in everyday clinical practice. Once pain mechanisms are identified, it becomes possible to provide treatment(s) become that directly target those mechanisms. Individual pattern and combination of background mechanisms can be found by each person, therefore, for example, even in the case of the same diagnosis, different factors may play a role in the development of pain (Chimenti et al., 2018). The overall aim of our research was to study and understand a specific set of psychosocial mechanisms associated with childhood environmental conditions.

7.1. The role of unpredictability

A chronically uncertain environment experienced during childhood is known to contribute to alterations in the physiological stress response system and, in the long term, sensitizes the brain to environmental stress (Wadsworth, 2015). This process is based on changes in the regulation of the hypothalamic-pituitary-adrenal (HPA) axis, a key biological cascade regulating the stress response (van Bodegom et al., 2017; Agorastos et al., 2018). However, the exact direction of the change in HPA functions has not yet been fully identified, and previous empirical studies have observed both hypo- and hypersensitivity of the HPA system as a possible consequence of prolonged early life stress (Liu and Nusslock., 2018; Agorastos et al., 2019; Kamkar et al., 2021). In addition to altered HPA axis regulation, long-term neuromorphological changes have been observed in individuals exposed to higher levels of environmental stress during childhood. Areas of the amygdala, hippocampus, prefrontal cortical regions, and cingulate cortex are all particularly sensitive to adverse early life circumstances (Tottenham and Sheridan, 2010; Agorastos et al., 2018; McLaughlin et al., 2019; González-Acosta et al., 2021).

The aforementioned stress-related changes may lead to the formation of the so-called unpredictability schema and thus contribute to the perception of life events as unpredictable and uncontrollable (Ross and Hill, 2002; Cabeza de Baca et al., 2016; Proffitt Leyva and Hill, 2018). The unpredictability schema can be an important element of the coping repertoire, aiming to protect against unexpected and adverse environmental effects (Ross and Hill, 2002; Mittal et al., 2015; Cabeza de Baca and Albert, 2019) However, the dominance of the unpredictability schema can increase the risk of undesirable psychosocial outcomes. For example, it may encourage a withdrawn, avoidant behavioral style, thereby undermining active attempts to solve problems and regulate emotions (Felton & Revenson, 1984; Yeo et al., 2014; Finkelstein-Fox & Park, 2019). This can have a particularly negative impact on coping with pain. Proactivity, active coping efforts, and attempts to regulate pain-related emotions are generally beneficial in pain evaluations and responses to pain (Jensen & Karoly, 1991; Brown & Jones, 2010; Schultz & Ryan, 2019). Accordingly, an unpredictability schema opposed to active, personal self-efficacy-based problem solving may lead to increased negative feelings about pain (Ross & Hill, 2002; Schwerdtfeger et al., 2006; Tinti et al., 2011).

Consistent with the above, the results of our first and second studies, which found that lower levels of perceived control (represented by the unpredictability schema) are associated with increased pain sensitivity, pain catastrophizing, and fear of pain, suggest that improving the sense of control may reduce negative psychological pain-related attitudes. There is much evidence that mindfulness meditation, cognitive behavioral therapy, or a combination of the two are effective tools in the treatment and management of chronic pain, in part through mechanisms that improve perceived control over pain (Morone et al., 2008, Marchand, 2012, Veehof et al., 2016; Day, 2017; Thorn, 2017; Day et al., 2019).

7.2. Changes in body-related attentive processes

Repeated and/or excessive activation of stress-related response systems and the associated functional-structural changes may be associated with increased reactivity to environmental stressors and with an external attentional focus (Schulz and Vögele, 2015; Murphy et al., 2017). Efforts to cope with a stressful environment may change the focus of attention: the focus on external environmental events increases (exteroceptive attention), while bodily awareness, the ability to identify and observe bodily sensations (interoceptive attention) decreases (Di Lernia et al., 2016; Price and Hooven, 2018; Schultchen et al., 2019; Hechler, 2021).

Consistent with this, in the models presented in the first and second studies, attentional processes related to one's own body (i.e., body awareness) mediated the effect of the unpredictability schema on pain variables. The finding that body awareness is related to both the unpredictability schema and pain indicates the relevance of interventions that involve changing patients' body awareness as a tool for pain therapy. In body awareness therapies, patients are taught to direct their attention and to increase non-judgmental body awareness, so that they can better change their focus and improve their bodily awareness (see Malmgren-Olsson et al., 2001; Price and Mehling, 2016, Lundwall et al., 2019; Skjaerven et al., 2019; Gard et al., 2020). Body awareness therapy can have many positive effects, like decreased somatic complaints, less pain, fewer negative emotions, improved quality of life, changes in the relationship with oneself, pain, and one's own body (Seferiadis et al., 2016; Sertel et al., 2017; Gard et al., 2020).

Our analyzes showed that a higher level of unpredictability schema associated with lower body awareness, which was negatively related to pain catastrophizing, pain sensitivity, and fear of pain. The negative direction of the relationship between the unpredictability schema and body awareness is also consistent with the aforementioned research. This suggests that in order to adapt to the adverse and unpredictable external environment, the perception and attentional processing of external signals becomes more emphasized, to the disadvantage of interoceptive processes (Mittal et al., 2015; Schulz and Vögele, 2015; Murphy et al., 2017; Proffitt Leyva and Hill, 2018). As a result, this shift in attention may result in the amplification of the affective value of pain-related signals and a reduction in the ability to control pain. The therapeutic methods mentioned above can positively influence these relationships, helping to cope with pain.

7.3. The role of the past-negative perspective

Our results (study 3 and 4) indicate that the relationship between negative childhood experiences and pain is revealed indirectly, through special, unique cognitive patterns. Our research has shown that attitudes towards pain are influenced by emotional states and cognitive factors that are not necessarily specific to the context of the pain but are related to many other negative and unpleasant memories. That is, memories do not have to be specifically related to pain, distortions associated with negative childhood memories in themselves have a specific influence on pain. The emphasis on negative memories may also result in an increased attentional bias towards pain: the aversive nature of pain may be reinforced by negative emotions that are specifically related to past negative events and experiences. This can have negative consequences in current situations as well.

These results may confirm, for example, the importance of time perspective therapy in the treatment of pain. Time perspective therapy is a fairly new practice in which past-positive memories, moderate present-hedonism and a healthy future orientation are supported by creating a balanced time-perspective profile to help healing and recovery, for example in people with obsessive-compulsive disorder (OCD), post-traumatic stress disorder (PTSD), attention deficit hyperactivity disorder (ADHD), as well as in many other life situations and problems. (Zimbardo et al., 2012; Sword et al., 2014, Esfahani et al., 2015; Weissenberger et al., 2016, Zimbardo and Sword, 2017)

All of this confirms what we tried to point out: that in pain therapies, in addition to the biological aspects of pain, the consideration of various psychological and social factors and the personalization of therapies can be of high importance. Table 2 summarizes the pain mechanisms and therapeutic suggestions learned in the dissertation.

Table 2. Description of the mechanisms and different therapeutic options that affect pain, as identified in our studies. The aim can be to change cognitive schemas and cognitive biases that develop in connection with childhood living conditions, as well as to direct attention. Mindfulness and cognitive behavioral therapy methods can be useful therapeutic tools to address all the mentioned variables. It is important to individualize therapeutic options and methods, to consider individual life situations and bio-psycho-social factors.

Mechanisms influencing pain perception	Variables used in our studies	Therapeutic suggestions and options
the role of higher unpredictability	childhood unpredictability, unpredictability schema	mindfulness, cognitive behavioral therapy
changes in body-related attentive processes	(lower) body awareness	body awareness therapies
the role of negative memories	past-negative time perspective	time perspective therapy

8. List of publications

Publications related to thesis:
Simon, E., Zsidó, A. N., Birkás, B., & Csathó, Á. (2022). Pain catastrophizing, pain sensitivity and fear of pain are associated with early life environmental unpredictability: a path model approach. *BMC psychology*, *10*(1), 1-13. (Impact factor: 2.543)

Simon, E., Zsidó, A. N., Birkás, B., Gács, B., & Csathó, Á. (2022). Negative time perspective predicts the self-perceived affective and physical components of pain independently from depression, anxiety, and early life circumstances. *Acta Psychologica*, *224*, 103536. (Impact factor: 1.734)

Presentations and posters related to theses:

Simon E., Zsidó, A. N., Birkás B., Csathó Á. (2021) Early life environmental unpredictability predicts vulnerability to pain in adulthood. *EHPS 2021 35th Annual Conference of the European Health Psychology Society.* (online "Give me five minutes" short scientific presentation)

Simon E., Zsidó, A. N., Birkás B., Csathó Á. (2019) The impact of the childhood environment unpredictability on adult pain perception. *Medical Conference for PhD Students and Experts of Clinical Sciences,* Pécs (scientific presentation)

Simon E., Zsidó, A. N., Birkás B., Csathó Á. (2019) Examining the impact of childhood environmental unpredictability on adult pain perception. *VIII. Interdisciplinary Doctoral Conference*, Pécs (poster presentation)

Simon E., Zsidó, A. N., Birkás B., Csathó Á. (2019) Examining the impact of childhood environmental unpredictability on adult pain perception *XVI. Magatartástudományi Napok. "Új időknek új dalaival"*, Szeged (poster presentation)

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