Published in: Michel G (2007). Daily patterns of symptom reporting in families with adolescent children. British Journal of Health Psychology. 12(2), 245-260. DOI: 10.1348/135910706X102726

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Daily patterns of symptom reporting in families with adolescent children

Gisela Michel, PhD 1 2 3
1 University of Fribourg, Switzerland
2 New York University
3 University of Berne, Switzerland

Requests for reprints should be addressed to: Gisela Michel, Department of Social and Preventive Medicine, University of Berne, Finkenhuelweg 11, 3012 Berne, Switzerland. Phone +41 31 631 38 99, Fax +41 31 631 35 20, e-mail: michel@ispm.unibe.ch

Current: gisela.michel@unilu.ch

Acknowledgements: This research was supported by the Swiss National Science Foundation Grant 5004-047773 and 5004-47770 and by a Scholarship from the Swiss National Science Foundation (81FR-068850). The Fribourg Family Projects were initiated by Meinrad Perrez. I would like to thank Niall Bolger, Peter Wilhelm, Pat Shrout, Marci Gleason and two anonymous reviewers for their helpful comments on earlier versions of the draft.
Abstract:

Objectives: This study was designed to investigate how symptom reporting varies by time of day, day of week, gender and generation.

Design: Concurrent symptom reporting was assessed prospectively using a computer-assisted self-report method.

Methods: A computer-assisted self-observation method was used to assess concurrent somatic complaints six times a day for seven consecutive days. Parents and adolescents from 173 families (568 individuals) filled in questionnaires during a normal workweek. A generalized linear model approach for multilevel models was used to analyse the multiple daily observations.

Results: Results show a curvilinear within-day pattern for the reporting of somatic complaints, such that complaints were reported most in the morning and evening and least in the middle of the day. On weekends, participants reported fewer complaints in the evening. Women reported more symptoms throughout the day. Adolescents show an earlier and more pronounced increase in symptom reporting towards the evening. In addition, a slight decline in symptom reporting over the observation period was observed.

Conclusions: Symptom reporting changes throughout the day, and is influenced by gender, generation and day of week.
Daily patterns of symptom reporting in families with adolescent children

The experience of somatic symptoms is not uncommon for most people. These are mostly minor somatic complaints such as waking up with a headache or a sore throat or developing back pain over the course of the day. Most complaints\(^1\) tend to come and go throughout the day, but occasionally they persist over several days, such as in a cold or flu. The variation in temporal patterns of symptom experience has rarely been studied.

Symptom reporting has been studied extensively. In the 1980’s, in particular, its relation to neuroticism was intensively explored (Costa & McCrae, 1980, 1985; Watson, 1988; Watson & Pennebaker, 1989). Later, other personality characteristics were introduced to try to understand why certain individuals report more complaints than others (e.g. De Gucht, Fischler, & Heiser, 2004; Deary, Scott, & Wilson, 1997; Horner, 1996; Neitzert, Davis, & Kennedy, 1997; Sommers & Vodanovich, 2000; Wengler & Rosén, 1995). Most of this research has been conducted using retrospective questionnaires, and only few researchers have asked participants about their current complaints (Cohen, Doyle, Skoner, Fireman, & et al., 1995; Larsen, 1992; Salovey & Birnbaum, 1989). The use of diaries has increased the knowledge about situation covariates that influence symptom reporting (Brown & Moskowitz, 1997; Ferguson, Cassaday, Erskind, & Delahaye, 2004; Michel, in press; Rakowski, Julius, Hickey, Verbrugge, & et al., 1988; Schanberg et al., 2000; Steingrimsdottir, Vollestad, Roe, & Knardahl, 2004; van Wijk, Huisman, & Kolk, 1999).

However, the pattern of how symptoms are reported throughout the day has only rarely been studied (Godaert, Sorbi, Peters, Dekkers, & Geenen, 2001; Goebel & Cordes, 1990; Stone, Broderick, Porter, & Kaell, 1997). Circadian rhythms have been found for many physiological processes, such as the release of hormones or natural killer cell activity (Wang, Delahanty, Dougall, & Baum, 1998), one of the most obvious circadian rhythms being the wake-sleep rhythm associated with light and dark. Apart from basic physiologic rhythms, diurnal patterns in psychological experience have been found, e.g. for emotional state (Watson, Wiese, Vaidya, & Tellegen, 1999; Wilhelm, 2001). The aim of this study was to investigate time related changes in everyday somatic complaints for two samples of healthy families during a normal workweek. In addition to the daily pattern, possible other patterns on the weekend and for different family members were tested, as well as reactivity to the method used.

In an experimental study, Goebel and Cordes (1990) examined circadian rhythms of pain experience in human beings. Headaches were induced using an inflatable cuff in healthy men and women six times during a 24-hour period. Participants evaluated the steadily increasing pain by changing the position of a switch. Increased pain sensitivity during the night and lower pain sensitivity during daytime were found. Godaert et al. (2001) compared naturally occurring pain intensity during waking hours in three groups of patients with a chronic disease using computer-assisted self-observation. They found different trajectories for different diseases. Whereas the pain intensity increased during the day in patients with chronic pain disorder, it decreased slightly in migraine patients. Pain intensity in individuals suffering from rheumatoid arthritis did not change much over the course of a day. Stone et al. (1997) used an ecological momentary assessment method to assess pain and fatigue in patients with rheumatoid arthritis seven times per day. They found greater reported pain in the morning, which decreased until lunchtime and remained stable thereafter. Fatigue, on the other hand, was found to increase again in the afternoon.

Symptom reporting is influenced by many different variables that change throughout the day. Mornings, for example, are influenced by the night’s sleep (or past evening’s drinking
behaviour). Depending on the quality of sleep or the amount of alcohol consumed one might suffer from a headache in the morning or simply not feel well in general. In the evening, on the other hand, individuals are most likely tired from a long day’s work, and might again feel worse than throughout the active day. At the same time, the heightened activity of the day might decrease symptom reporting; one reason for this being the lack of attention to one’s own body (Eriksen & Ursin, 2004; Kolk, Hanewald, Schagen, & Gijsbers van Wijk, 2002; Williams & Wiebe, 2000). Such an attention shift might even amplify the findings of Goebel and Cordes (1990) where a lack of attention in the experimental setting could hardly be the main reason for the lower daytime pain-levels.

Keeping in mind that activities, attention and emotional state (Brown & Moskowitz, 1997; Cohen et al., 1995; Eriksen & Ursin, 2004; Salovey & Birnbaum, 1989) influence symptom reporting, days will differ from each other. In particular, weekends might differ from weekdays. Reduced distraction from work or other weekday activities might increase symptom reporting because more attention will be given to one’s own bodily experiences. On the other hand, weekends are often associated with better emotional well-being (Wilhelm, 2001), which could improve symptom experience and result in decreased reporting. A general increase or decrease of symptoms on the weekend, coupled with possible behavioural changes associated with weekends, may result in different within-day patterns found on Saturdays and Sundays.

Gender is an important factor that has been consistently found to be highly associated with symptom reporting (Al-Windi, 2004; Kroenke & Spitzer, 1998; Williams & Wiebe, 2000). Women report not only more but also more intense somatic complaints than men (for a review see Barsky, Peekna, & Borus, 2001). In a medical patient population, women have been found to report most symptoms 1.5 to 2 times more frequently, even if gynaecological symptoms are not taken into account (Kroenke & Spitzer, 1998). Regarding medically unexplained symptoms, women often report these symptoms in such a strength that it can be diagnosed as a somatoform disorder, and at the same time, these disorders are consistently more prevalent in women than in men (Kaemmerer, 2001). Goebels and Cordes (1990) found differences in the experience of pain between men and women in their pain-induction experiment, such that women showed higher pain sensitivity. While gender differences are well established for retrospective symptom reporting, they have rarely been studied in concurrent symptom reporting.

Children, in contrast, have only rarely been studied in regard to symptom reporting (Schanberg et al., 2000). Fearon, McGrath and Achat (1996) have studied symptom reporting in very young children (between 2 and 7 years of age) and found higher symptom reporting for girls already at this age. Adults and children are differing in their daily activities and also in their susceptibility to infections and may thus also differ in their experience of symptoms, especially in the daily pattern of symptom reporting.

In the past, retrospective questionnaires were used in order to assess somatic symptoms, but such reports can be problematic. Retrospective reports are highly influenced by memory effects (Gorin & Stone, 2001; Stone, Broderick, Kaell, DelesPaul, & Porter, 2000) or the personality characteristic of neuroticism (Brown & Moskowitz, 1997), and are therefore often of limited value. Margraf and Jacobi (1997) found that panic patients report many more and heavier symptoms when asked some days after a panic attack than when asked in the panic situation.
itself. A similar deterioration of retrospective self-reports (retrospection effect) in a student sample was found by Kaeppler and colleagues (Fahrenberg, Bruegner, Foerster, & Kaeppler, 1999; Kaeppler & Rieder, 2001). Concurrent assessment of the concept of interest should therefore lead to more accurate results.

At the same time, these assessment methods put some demand on participants. Diaries or multiple self-observations ask participants once or several times per day about their current complaints. This procedure is repeated for several days or even weeks requiring a serious commitment from participants. It might therefore lead to decreased compliance (reactivity to the method). Participants might get to know the questions and get bored with answering them, or try to fill out the questionnaire in a less time-consuming way (e.g. by negating the experience of complaints, if the questions concerning somatic complaints is hierarchical and thus includes follow-up questions if complaints are affirmed).

In the present study we therefore examined the following hypotheses: We expected 1. a curvilinear pattern of symptom reporting such that the probability to report symptoms is higher in the morning and in the evening and lower in the middle of the day; 2. a difference in pattern of symptom reporting between work days and weekends; 3. a gender difference such that women have a higher probability to report symptoms; 4. a reactivity effect such that the probability to report symptoms is decreasing towards the end of the observation week. In addition, the effect of generation was estimated in an exploratory way. The analysis was done on a combined sample from the Second and the Third Fribourg Family Project (Perrez, Schoebi, & Wilhelm, 2000).

**Method**

*Participants*

One-hundred and one families from the Second Fribourg Family Project (Sample 1) and 78 families from the Third Fribourg Family Project (Sample 2), respectively, were recruited by sending information brochures to all the families with adolescent children at schools in and around Fribourg and Bern in Switzerland (approximately 5200 letters for Sample 1 and 2600 for Sample 2). For Sample 2 only seventh and eighth graders (13-14 years old) were sent information. In addition, recruiting was done by advertising the research project in local and national newspapers and magazines. Families interested in participating returned an application form and were afterwards contacted by a member of the research team. Because a major focus of both projects was parent-adolescent relationships, only families with two parents and at least one child older than 13 years were allowed to participate. Siblings were allowed to participate in the study. In Sample 1, two families decided not to participate before the self-observation started, two families terminated the observation early, and one family experienced many technical problems. The data of these families are not included, leaving 96 families for the present analysis. In Sample 2 one family declined to participate when visited by our collaborator but before starting the self-observation, leaving 77 families for the analysis.

In the Sample 1, the mean age of the 192 parents was 45.9 years (SD = 5.8; age range = 32 to 64). One hundred twenty two children participated, 66 boys and 56 girls. Their mean age was 15.3 years (SD = 1.0; age range = 13 to 19). In Sample 2, the mean age of the 154 parents was 44.3 years (SD = 4.0; age range = 35 to 56). Of the 100 participating children 44 were boys and 56 were girls. Their mean age was 13.8 years (SD = 1.1; age range = 10 to 17). Because the two samples were shown to be highly similar they were combined for the data analysis.  

2. 
Procedure

In order to have valid data about the experience of complaints throughout the day, we applied time-sampling in an ecological momentary assessment method (Czikszentmihalyi & Larson, 1987; Larson & Czikszentmihalyi, 1983; Stone, Shiffman, & DeVries, 1999). The data were collected by a computer-assisted self-observation method (FASEM-C, Perrez et al., 2000). Computer-based diary methods have been shown to produce more valid data than paper- and pencil diaries by reducing artefacts arising from retrospective reports (i.e. late reports due to impaired compliance; Stone, Shiffman, Schwartz, Broderick, & Hufford, 2002). Our procedure increases compliance to answer the questions at the scheduled time, by inhibiting late answering (after the next questionnaire is due, for details see Perrez et al. 2000). Therefore no retrospective reporting is allowed for (which admittedly slightly increases the amount of missing data).

To introduce the computer-assisted self-monitoring system families were visited at home by a collaborator and were shown the exact procedure on the handheld computer. In the case of questions or problems this collaborator could be reached by phone during the whole observation period. Every participating family member (father, mother and at least one child older than 13 years) had their own handheld computer (HP 200 LX), which they started themselves in the morning just after getting up by touching the screen. At that time they answered a series of questions by touching the most appropriate box on the screen. This procedure was repeated five more times per day following an alarm-signal. These signals were randomly distributed within the same hour every day for one week, but at the same time for every family member (between 9 and 10am, 12 and 1pm, 3 and 4pm, 6 and 7pm, 9 and 10pm).

For the present analysis only data from the first seven days of self-observation was used, even if some participants filled in the questionnaire for more than seven days. From all participants we have a total of 21801 observed situations (12153 in Sample 1 and 9648 in Sample 2). There were 8.5% of missing observations. Data were gathered between November 1998 and April 2000 (Sample 1) and between January 2001 and May 2003 (Sample 2).

Measures

Self-observation (FASEM-C):

Somatic complaints were assessed by asking participants at every observation point: “Are you currently experiencing any kind of physical complaints or pains?” If this question was answered affirmatively, participants were asked to specify the kind of complaint (e.g. headache, neck-pain, sore throat, exhaustion) and its cause (e.g. stress, weather, flu, injury) from a list. For the present paper only the first question about the presence or absence of complaints or pains was used. Confirming the experience of somatic complaints was scored 1, not experiencing any complaints was scored 0.

Time

Three time factors were entered to the model. The first is the time-point during the day to describe the pattern in symptom reporting during the day. The second was the day into the observation period (different families started at different week-days). This day-into-study-effect was included in order to test reactivity to the method. Both the within-day and the day-into-study effects were entered as orthogonal polynomials up to the cubic trend (a linear, a quadratic and a cubic trend) in order to eliminate collinearity between the three trends. The third time-effect
entered was a dummy-coded variable each for Saturday and Sunday, coded 0 for weekdays and 1 for Saturdays and Sundays, respectively.

Data analysis

The time-sampling procedure to assess symptom reports in families results in hierarchically structured data. Individual reports are nested within days, days within individuals and individuals within families. We therefore differentiate between four levels: Level 1 comprises the individual diary reports (= 21801); Level 2 comprises the person-days (N = 3901); Level 3 comprises the persons (N = 568), and level 4 comprises the families (N = 173). In order to include all the information, as well as to account for similarities within different levels (family, person or day), we used a multilevel statistical model as implemented in the MLwiN software (Rasbash et al., 2000). The multilevel structure does not require balanced data and missing data are thus not a problem for the analysis. Because symptom reporting was measured as a binary variable, a generalized linear models approach to multilevel data with a logit link function was used (Goldstein, 1995). First-order marginal quasilikelihood (MQL) estimation was used for all models (as recommended by Snijders & Bosker, 1999). Extra-binomial variation was allowed for (Goldstein, 1995). In order to test the hypotheses, first a basic model for the time-of-day influences was analysed followed by a final model including all other predictors. The following model specification was used for the basic model estimating the within-day pattern for \( \pi_{ijkl} \), where i is occasion, j is day, k is individual and l is family, and \( \pi \) is the probability of reporting complaints:

\[
\logit (\pi_{ijkl}) = \beta_{1jkl} + \beta_{2jkl} time_{ijkl} + \beta_{3jkl} time_{ijkl}^2 + \beta_{4jkl} time_{ijkl}^3
\]

All the time effects are entered as orthogonal polynomials, such that the intercept represents the middle of the day: time is a linear, time\(^2\) is a quadratic, and time\(^3\) is a cubic time effect. \( \beta_{ijkl} \) represents the intercept and is allowed to vary on the family- (f\(_l\)), the person- (v\(_{kl}\)), and the day-level (u\(_{ijkl}\)), (i.e. different intercepts can be estimated for each family l, for each individual k in family l, and for each day j, in individual k, in family l). The lowest level random effect is given by the expected probability \( \pi_{ijkl} \) and allowed for extra-binomial variation, represented by the multiplier e\(_{ijkl}\) (see Table 3).

The three time effects are represented by \( \beta_{2jkl} \), \( \beta_{3jkl} \) and \( \beta_{4jkl} \). All time variables have a fixed effect (time\(^1\): \( \beta_2 \); time\(^2\): \( \beta_3 \); time\(^3\): \( \beta_4 \)) and a random effects at level 4 (family), level 3 (person) and level 2 (day) (for time\(^1\): f\(_l\), v\(_{kl}\) and u\(_{ijkl}\); for time\(^2\): f\(_{jl}\), v\(_{kl}\) and u\(_{ijkl}\); for time\(^3\): f\(_{jl}\), v\(_{kl}\) and u\(_{ijkl}\)). These random effects account for the possibility that time effects could differ from family to family, from person to person and from day to day.

The remaining predictors (day-into-study, weekend, gender and generation, and interactions thereof) were added as fixed effects (see Table 2). Day1, day2, and day3 describe the orthogonal polynomials up to the cubic trend for the day into study. The intercept represents the fourth day of self-observation. Saturday and Sunday and their interactions with time of the day are represented by saturday, saturday.time1, saturday.time2, and saturday.time3, and sunday,
sunday.time1, sunday.time2, and sunday.time3, respectively. Gender and generation, the interaction between them and the interaction with time of the day are represented by the remaining variables. Interactions between one variable and the time effects in the model allow to test for different daily patterns of symptom reporting on weekends, or by different family members. None of these variables has a random effect. Estimates shown in the tables are reported in log odds; in figures, they are shown as probabilities.

**Results**

Frequencies and probabilities of the observed complaints are given in Table 1.

To test if the probability of reporting complaints changes during the day, the basic model represented in equation (1) was estimated. The estimates for the basic model including fixed and random effects are shown in Table 2 and Table 3. Both quadratic and cubic time patterns are found to be significant predictors of somatic complaints in both samples. The probability of reporting a complaint increases in the evening, after a reduced reporting during the day. Random effects show significant variation on the person- and the day-level for the intercept and the time trends. Table 1 reports the predicted probabilities of symptom reporting, and Figure 1 shows the pattern during weekdays and weekends.

In the final model we tested for the association with the other predictors. A significant linear and cubic effect for reactivity (variables Day1 and Day 3) was found, i.e. individuals report fewer complaints at the end of the study than at the beginning, with a slight increase again on the last day (Table 2). In Figure 2 the reactivity effect can be seen. The linear reactivity effect corresponds to a 0.005 decrease in the probability of reporting complaints every day.

Contrary to the hypothesis that individual symptom experience increases or decreases on weekends compared to weekdays, we did not find a significant main effect for weekend. However, the interaction with time of the day was significant for the quadratic trend on Saturday and for the linear trend on Sunday. On Sunday the reporting of complaints decreases significantly during the course of the day (Table 2). The expected probabilities are shown in Figure 1.

We found a significant gender difference, such that women are more likely to report complaints (0.202 on average) than men (0.149 on average) throughout the day. No interaction effect was found for gender and time, nor gender x generation x time. But children show a significant interaction with the linear time effect, which suggests that they have an increase of symptom reporting especially during the second half of the day. Estimates for all fixed and random effects of the final model are presented in Table 2 and Table 3. Figure 2 shows the trajectories for the family members during the study.

The same model was analysed separately for four specific complaints, which were present in at least 5% of the total observations: headache (N=1132; 5.2%), neck pain headache (N=1510; 6.9%), sore throat (N=1083; 5.0%) and exhaustion (N=1094; 5.0%). Taking into account the very low number of observed symptoms for each specific complaint results are similar to the overall model (Table 4).

**Discussion**

The current study provides support for the existence of a curvilinear daily pattern of symptom reporting. Results showed that complaints are reported more often in the morning and in the evening and less frequently during the day. This was true for both parents and children.
Saturdays and Sundays clearly differ from this picture. In contrast to weekdays, symptom reporting is reduced on weekend evenings. Men and women differ significantly in the amount of symptoms they report in that women report more symptoms. Generation differences point to a bigger increase of complaints towards the evening in adolescent’s reporting. A linear decline of symptom reporting was found during the observation week, which indicates reactivity to the method.

**Daily pattern**

The results of two combined samples with 173 families show the predicted daily pattern of symptom reporting. Early in the morning and late in the evening more complaints are reported than throughout the day. The fewest complaints are reported around lunchtime. This pattern can also be observed in various specific complaints such as neck pain or sore throat. The outcome is compatible with the daily pattern found by Goebel and Cordes (1990), when studying pain sensitivity throughout a 24-hour cycle.

An important reason for this might be the reduced attention to one’s own body during working and school hours. Additionally, interactions with other persons, activities and emotions differ during these times (Wilhelm, 2001), and might have an effect on if and how symptoms are perceived. While negative emotions may increase symptom reporting, an interesting interaction with another person or an exciting activity may reduce the experience of adverse symptoms. In a post-hoc analysis of the two samples the influence of stress, conflict and activity on the daily pattern of symptom reporting was analysed. While reporting stress (estimate in log odds = 0.217; SE = 0.087; \(\chi^2 = 6.155; p = 0.013\)), or conflict (estimate = 0.139; SE = 0.046; \(\chi^2 = 9.304; p = 0.002\)), and doing something alone (estimate = 0.123; SE = 0.029; \(\chi^2 = 18.21; p < 0.000\)) increase symptom reporting, participating in a positively evaluated activity reduces symptom reporting (estimate = -0.107; SE = 0.012; \(\chi^2 = 82.48; p < 0.000\)). However, the daily pattern remained the same. Only in women stress increased symptom reporting slightly at the end of the day (estimate = 0.048; SE = 0.022; \(\chi^2 = 4.635; p = 0.031\)). A future study should have a closer look at how emotional state influences the experience of complaints.

This curvilinear daily pattern of symptom reporting is just a general pattern found over all participants. The significant random effects (Table 3) show that individuals differ highly from one another and so do days within individuals (the individual probabilities to report symptoms reach from 3.4% to 99.7%). Therefore even if in general people report more complaints in the morning and in the evening, each individual has a different trajectory, and this individual trajectory can change from day to day. One person might have problems with getting up in the morning and feel very tense and stiff most of the days, but recovers as soon as starting work. Another might be very exhausted in the evening and suffer from headaches frequently late in the day. Other people suffered from a cold or flu during the observation week and therefore had some days with persistent complaints. Within these people, however, days might have been very different in regard to complaints, if the cold only started in the second half of the week. We can therefore conclude that albeit having a general pattern of symptom reporting, individuals differ in their daily pattern. To understand individual patterns more profoundly, other variables that influence symptom reporting have to be taken into account.

**Weekend: Saturday and Sunday effects**

This daily pattern of symptom reporting was found to differ on weekends. Saturdays and Sundays symptom reporting is dropping during the day. In contrast to weekdays, fewer
symptoms are reported in the evening. One explanation for this could be distraction, which would be expected to be higher especially for adolescents on Saturday evenings. Activities are often very different on weekends than during work- or school-week. This in turn could result in changes of attention, which would be drawn away from somatic complaints. At the same time, emotional states have been found to be more positive during weekends (Wilhelm, 2001), which could result in a general decrease of symptom experience. This reasoning is in line with findings that show a close relation between negative affective state and symptom reporting (Brown & Moskowitz, 1997; Cohen et al., 1995; Salovey & Birnbaum, 1989; Williams & Wiebe, 2000). However, our results are not very conclusive in this regard and further investigation concerning the change of symptom report on weekends is desirable.

Gender

Most research in symptom reporting has found gender differences, such that women report many more and more intense symptoms than men (Al-Windi, 2004; Neitzert et al., 1997; Rollman & Lautenbacher, 2001; van Wijk et al., 1999; Williams & Wiebe, 2000). This difference was also found in the current study. Throughout the observation week women reported about one third more complaints than men (average amount of situations when complaints are reported: Women: 20.2%; Men: 14.9%). However, there is no gender difference in regard to the daily pattern of symptom reporting. Both men and women, therefore, report more complaints in the morning and in the evening and fewer during daytime. This is interesting because men and women in our sample differ highly in their employment status; significantly more men than women are employed full-time ($\chi^2 = 200.8; df = 1; p < 0.001$). Although employment and absence of employment may structure the day of men and women quite differently, it does not seem to have an effect on the daily pattern of symptom reporting.

Generation

For the first time, to our knowledge, this study has looked at differences between generations in symptom reporting in a very detailed way. Results show no significant difference between adolescents and parents in regard to their average report of complaints. However, adolescents have a different daily pattern. Figure 2 shows that boys and girls have a remarkable increase of symptom reporting later in the day, whereas parents report lower levels of complaints in the evening than in morning hours.

So far we can only hypothesize about why this is the case. One explanation would be that children experience increased tension and tiredness during and after school, which makes them more vulnerable for somatic complaints. However, to further explain the association a closer look at the situational differences between parent and adolescent’s daily life has to be taken.

Limitations

A limitation of the assessment method is its susceptibility to reactivity. Using a method to assess symptom reporting, which is as demanding as the self-observation used in both Fribourg Family Projects, one has to expect some reactivity, (i.e. some influence on the answering behaviour of the participants). A single report took an average of 5.8 minutes ($SD = 3.33$), which is a considerable amount of time to spend on questionnaires six times per day. Indeed, we found a significant decline of symptom reporting during the study. Participants selected the having-
complaints option in the diary slightly less often at the end of the study than at the beginning, most likely due to a tiring effect and due to the structure of the question. The questionnaire can be abbreviated by choosing the no-complaints option. This answer circumvents two further questions investigating the kind of complaint and its attribution. The daily pattern found in the present study might thus partly be due to participants abbreviating the questionnaire during the day while they were at work or in school. Questions that prompted additional questions might have been answered more often in the morning and in the evening resulting in the curvilinear pattern. Not including the follow-up questions, or reducing the length of the whole questionnaire could minimize this effect. However, as shown in this study the overall-effect of reactivity is only minor and does not affect the conclusion that can be drawn from these two studies otherwise. The advantages in comparison to retrospective reports seem to outweigh these reactivity effects.

An important limitation of this study is its reliance on a very specific sample. The samples of both projects, although recruited from a very broad population, were self-selected, and only families with at least three members interested in participating would apply. But apart from their interest in academic research, and willingness to spend a considerable amount of time to be part of these projects, they are not expected to differ highly in the measured variables from the general population. And though they mainly represent upper middle-class Swiss parent and adolescent, results from this large sample still give a very good first impression of what the daily pattern in symptom reporting looks like, and gives an important insight into how symptoms are experienced and reported throughout the day and during the week.

However, we cannot but hypothesize why the pattern is curvilinear during weekdays and negative cubic at the weekend. Future studies have to take other factors into account, which could supposedly explain this pattern. As mentioned above the emotional state as well as the activity and attention at a certain time-point might influence symptom reporting regardless if symptoms are experienced or not. In addition, social interactions could very well be a distraction from symptom experience if the interaction is of a positive value. In addition, a positive social interaction might lead to reactivity, such that the questionnaire is answered in the shortest possible way (i.e. by negating somatic complaints). In any case, situational aspects play an important role for symptom reporting.

Using very computer-assisted diary methods, the curvilinear pattern found in earlier studies (Goebel & Cordes, 1990) was replicated for men and women of the parent and the adolescent generation and it was shown that other patterns exist for weekends.
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Footnotes

1 The terms complaints and symptoms are used interchangeably.
2 We tested for differences between the two samples in regard to all predictor variables. There was only one difference concerning the linear time effect on Sunday. The difference was very small (though significant; $\beta = 0.056$; SE = 0.024; $\chi^2 = 5.548$; $p = 0.019$). In addition, the inclusion of a predictor for the sample membership and its interaction with the time effects in the final model showed no significant difference between the two samples. We thus chose to combine the samples, without including the sample as a covariate.
3 We tested for differences among the weekdays. No significant differences were found for the days Monday through Friday.
Table 1: Observed and predicted probabilities of complaints for the six observations of the day

| Time of Day | Observed No complaints | Observed Complaints | Predicted Complaints |
|-------------|------------------------|---------------------|----------------------|
|             | N         | N | Prob. | N         | N | Prob. | Prob. |
| Getting up  | 2800      | 781 | 0.218 |            |      | 0.222 |
| 9-10am      | 3004      | 624 | 0.172 |            |      | 0.175 |
| 12-1pm      | 3027      | 636 | 0.174 |            |      | 0.167 |
| 3-4pm       | 3022      | 635 | 0.174 |            |      | 0.177 |
| 6-7pm       | 2990      | 717 | 0.193 |            |      | 0.193 |
| 9-10pm      | 2875      | 690 | 0.194 |            |      | 0.197 |
| Total       | 17718     | 4083 | 0.187 |            |      | 0.188 |
Table 2: Estimates and SE of fixed effects for all predictors of the basic and the final model

|                  | Basic Model |                  | Final Model |                  |
|------------------|-------------|------------------|-------------|------------------|
|                  | Estimate    | SE              | Chi²        | p               |
| Intercept        | -1.464      | (0.068)         | 462.756     | < 0.001         |
| Time1 (linear)   | -0.005      | (0.006)         | 0.728       | 0.397           |
| Time2 (quadratic)| 0.027       | (0.004)         | 43.123      | < 0.001         |
| Time3 (cubic)    | -0.010      | (0.002)         | 19.786      | < 0.001         |
| Day1             | 0.026       | (0.064)         | 0.161       | 0.688           |
| Day2             | 0.004       | (0.006)         | 0.342       | 0.559           |
| Day3             | 0.066       | (0.023)         | 8.062       | 0.005           |
| Saturday         | 0.026       | (0.064)         | 0.161       | 0.688           |
| Saturday.time1   | -0.030      | (0.010)         | 8.912       | 0.003           |
| Saturday.time2   | -0.017      | (0.012)         | 2.014       | 0.156           |
| Saturday.time3   | -0.002      | (0.006)         | 0.109       | 0.741           |
| Sunday           | -0.030      | (0.065)         | 0.209       | 0.648           |
| Sunday.time1     | -0.018      | (0.010)         | 3.146       | 0.076           |
| Sunday.time2     | -0.000      | (0.007)         | 0.001       | 0.975           |
| Female           | 0.365       | (0.160)         | 5.228       | 0.022           |
| Female.time1     | -0.012      | (0.012)         | 1.034       | 0.309           |
| Female.time2     | -0.012      | (0.011)         | 1.247       | 0.264           |
| Female.time3     | -0.003      | (0.006)         | 0.258       | 0.612           |
| Child            | 0.144       | (0.184)         | 0.616       | 0.433           |
| Child.time1      | 0.076       | (0.014)         | 28.250      | < 0.001         |
| Child.time2      | -0.009      | (0.012)         | 0.484       | 0.487           |
| Child.time3      | -0.003      | (0.007)         | 0.175       | 0.676           |
| Female.child     | 0.056       | (0.261)         | 0.046       | 0.830           |
| Female.child.time1| -0.024     | (0.020)         | 1.434       | 0.231           |
| Female.child.time2| 0.008      | (0.017)         | 0.246       | 0.620           |
| Female.child.time3| 0.014      | (0.010)         | 2.201       | 0.138           |
Table 3: Estimates and SE of the random effects of the basic and the final model (covariances are not shown)

|                  | Basic Model |                  | Final Model |                  |
|------------------|-------------|-----------------|-------------|-----------------|
|                  | Estimate    | SE              | Chi²        | p               |
| **Family-level Variances** |    |                  |             |     |
| intercept        | 0.164       | (0.092)         | 3.181       | 0.074 |
| time1            | 0.001       | (0.001)         | 3.725       | 0.052 |
| time2            | 0.000       | (0.000)         | 0.000       | 0.999 |
| time3            | 0.000       | (0.000)         | 0.000       | 0.999 |
| **Person-level Variances** |    |                  |             |     |
| intercept        | 1.812       | (0.146)         | 153.839     | < 0.001 |
| time1            | 0.004       | (0.001)         | 14.128      | < 0.001 |
| time2            | 0.003       | (0.001)         | 23.952      | < 0.001 |
| time3            | 0.000       | (0.000)         | 3.043       | 0.081 |
| **Day-level Variances** |    |                  |             |     |
| intercept        | 1.338       | (0.045)         | 865.578     | < 0.001 |
| time1            | 0.026       | (0.002)         | 227.613     | < 0.001 |
| time2            | 0.011       | (0.001)         | 85.104      | < 0.001 |
| time3            | 0.003       | (0.001)         | 23.904      | < 0.001 |
| **Extra-binomial multiplier (e_{ijkl})** | 0.402 | (0.007)         | 3522.836    | < 0.001 |
| -2*log likelihood | 11213.8 |                  |             | 10477.2 |

Note: Reduction in deviance (-2*log likelihood) is highly significant: $\chi^2 = 736.6; df = 23; p < 0.0001$
Table 4: Estimates and standard errors of the final model for four specific complaints

|                | Headache       | Neck pain      | Sore Throat    | Exhaustion     |
|----------------|----------------|----------------|----------------|----------------|
|                | Estimate (SE)  | Estimate (SE)  | Estimate (SE)  | Estimate (SE)  |
| Intercept      | -3.451* (0.167)| -2.683* (0.195)| -3.283* (0.265)| -3.236* (0.191)|
| Time1 (linear) | 0.003 (0.021)  | -0.011 (0.014) | -0.032* (0.016)| -0.022 (0.019) |
| Time2 (quadratic)| 0.026 (0.015)| 0.050* (0.012)| 0.025* (0.011)| 0.053* (0.017)|
| Time3 (cubic)  | -0.014 (0.010) | -0.011 (0.007) | 0.001 (0.007)  | -0.026* (0.010)|
| Day1           | -0.063* (0.021)| -0.056* (0.016)| -0.062* (0.024)| -0.058* (0.018)|
| Day2           | 0.003 (0.012)  | 0.019* (0.009) | 0.014 (0.014)  | 0.004 (0.010)  |
| Day3           | 0.091* (0.045) | -0.015 (0.034) | 0.119* (0.051) | -0.003 (0.039) |
| Saturday       | -0.029 (0.124) | 0.163 (0.094)  | 0.015 (0.139)  | -0.139 (0.111) |
| Saturday.time1| -0.057* (0.025)| -0.015 (0.018) | -0.027 (0.019) | -0.003 (0.023) |
| Saturday.time2| -0.003 (0.019)| -0.033* (0.015)| -0.033* (0.014)| -0.022 (0.021) |
| Saturday.time3| -0.009 (0.012) | -0.002 (0.009) | 0.001 (0.009)  | -0.017 (0.014) |
| Sunday         | -0.126 (0.127) | 0.074 (0.096)  | -0.116 (0.142) | -0.242 (0.115) |
| Sunday.time1  | 0.000 (0.027)  | -0.045* (0.019)| -0.031 (0.020) | 0.044 (0.025)  |
| Sunday.time2  | -0.038 (0.020) | -0.030 (0.016) | -0.001 (0.015) | -0.025 (0.022) |
| Sunday.time3  | 0.009 (0.013)  | -0.008 (0.010) | -0.002 (0.009) | 0.000 (0.014)  |
| Female         | 0.812* (0.221) | 0.261 (0.259)  | -0.433 (0.364) | 0.376 (0.261)  |
| Female.time1  | -0.035 (0.026) | -0.026 (0.018) | 0.002 (0.022)  | -0.004 (0.024) |
| Female.time2  | -0.031 (0.018) | -0.022 (0.016) | -0.006 (0.016) | -0.008 (0.022) |
| Female.time3  | 0.005 (0.012)  | -0.005 (0.008) | -0.016 (0.010) | 0.016 (0.012)  |
| Child          | 0.386 (0.255)  | -0.803* (0.302)| 0.590 (0.414)  | 0.076 (0.300)  |
| Child.time1   | 0.064* (0.031) | 0.051* (0.024) | 0.035 (0.023)  | 0.124* (0.028) |
| Child.time2   | -0.020 (0.022) | 0.022 (0.022)  | 0.009 (0.015)  | 0.014 (0.026)  |
| Child.time3   | -0.004 (0.014) | -0.013 (0.013) | -0.013 (0.010) | 0.001 (0.015)  |
| Female.child  | -0.370 (0.360) | 0.783 (0.429)  | 0.934 (0.587)  | 0.252 (0.423)  |
| Female.child.time1 | 0.018 (0.041) | -0.020 (0.032) | -0.005 (0.033) | -0.068 (0.038) |
| Female.child.time2 | 0.028 (0.028) | -0.018 (0.028) | 0.003 (0.022)  | -0.029 (0.035) |
| Female.child.time3 | -0.002 (0.018)| 0.028 (0.016)  | 0.024 (0.014)  | -0.003 (0.019) |

*p<0.05
Figure 1: Expected probabilities and 1.96 x SE for weekday and weekend patterns
Figure 2: Expected probabilities to report a somatic complaint during a seven-day observation period including reactivity effects, separated for family-members