Travel-Related Change of Residence Leads to a Transitory Stress Reaction in Humans

Gerhard W. Blasche, PhD,*† Klaus Weissensteiner, MA,† and Wolfgang Marktl, MD†

*Department of Environmental Hygiene, Centre for Public Health of the Medical University of Vienna, Vienna, Austria; †Ludwig Boltzmann Institute for Biological Rhythm Research, Bad Tatzmannsdorf, Austria

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Objective. It is well known that animals show a stress response when confronted with a novel environment. The aim of the this study was to investigate whether humans show a similar response by studying the reaction to a travel-related transitory change of residence.

Method. Forty-eight individuals (32 women, 16 men, age 40–83 years) traveling to a health resort approximately 120 km from their home town participated in the study. Individuals monitored their blood pressure (BP) twice a day 3 weeks before (baseline) and during the stay and filled out a diary stating their mood and sleep. The change of the variables relative to baseline on the day before departure, the travel day, and the day after arrival as well as 5 days after arrival were determined.

Results. Systolic and diastolic BPs were increased on the day before travel and diastolic BP remained increased on the travel day and the day after arrival. Sleep was poorer during the first night at the new residence. All three variables had returned to baseline level 5 days into the stay. Mood was not affected by the change of residence.

Conclusion. The results indicate that not only the change of residence but also its anticipation affects individuals in a transient way. The findings are relevant not only for the basic understanding of the reaction to novel environments but also to travel, tourism as well as rehabilitation, and spa-research.

Humans as well as animals are sensitive to changes in their environment. The most prominent feature is the so-called orienting response, a short-term psychophysiological reaction improving information uptake and attention and potentially preparing for fight or flight when confronted with a novel stimulus.1–3 Typically, however, the individual will get used to the stimuli after repeated presentations or prolonged exposure and habituate, thereby ceasing to show any further response.4,5 In animals, a commonly used paradigm for the study of more enduring reactions is “environmental novelty” used to explore, among others, stress, fear, and exploration.6–9 The animal is thereby confronted with a novel object or placed in an unfamiliar surrounding while observing both behavioral and physiological variables. Typical reactions are freezing, exploration, and increases in heart rate and blood pressure (BP).10,11

Humans show reactions such as the “first-night effect,” a well-known phenomenon in sleep research.12–14 Humans sleeping in the surrounding of a sleep laboratory for the first time exhibit various disruptions of sleep which tend to vanish in the consecutive nights. Other more enduring novelty responses in humans include wearing an ambulatory BP monitoring device, coming to the clinic for BP assessment, or coming to the laboratory for an orthostatic strain test. These lead, among others, to a higher level of BP during the first compared to the second day of assessment.15–17 The described increases in cardiovascular activity and possibly also of sleep disturbance are most likely due to an increased beta-adrenergic arousal of the autonomic nervous system associated with active coping.18,19 In addition to reacting to novelty, humans also anticipate these events, thereby showing specific psychophysiological and behavioral changes preparing them for the future situation.20 These reactions have been studied extensively in the short-term anticipation of pain, but are also found in the long-term anticipation of stressful events such as job loss.21–23

However, despite the frequency of travel, the novelty response to our knowledge so far has not been studied in relation to a temporary change of residence (CoR) as occurs during travel, except for some older anecdotal reports on “environment shock” during travel24 and

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studies generally related to travel stress. Based on the previously mentioned facts, we assume that individuals will respond to a CoR by an increase of (1) systolic and (2) diastolic BP reflecting beta-adrenergic arousal, (3) a decrease in the quality sleep reflecting anxiety related to unfamiliarity, and (4) a decrease of mood also reflecting the tension related to a novel residence. We assume that these effects will be present both prior to and after the change of residence, due to anticipation of, and confrontation with the event, respectively. We do not expect these changes to be present any more than 5 days after the CoR because of habitation.

Methods

Study Participants

Individuals who were scheduled for a 3-week stay at the health resort Bad Tatzmannsdorf to receive spa treatment were contacted by mail at least 5 weeks prior to their stay and asked whether they were interested in participating in a study on BP changes prior to, during, and after spa therapy. The study focus on change of residency was not explicitly stated. The sole inclusion criterion was living in the vicinity of Vienna to enable participants to receive and be trained in the use of the BP monitor at our department and to limit travel duration. The distance between Vienna and Bad Tatzmannsdorf is 120 km. Exclusion criteria were diseases limiting cardiovascular functioning, physical fitness, and mobility (eg, heart failure, pacemakers, ongoing chemotherapy, infectious diseases, etc.), having an additional vacation during the study phase, change of antihypertensive medication in the study phase, and taking sedatives during the study phase. Forty-eight individuals (32 women, 16 men, age 40–83 years) participated in the study. The average weekly work hours of the 34 occupationally active individuals was 39.3 (SD 14.4) hours, 11 individuals reported having shift work, 12 individuals had blue-collar, and 22 white-collar occupations. Those 11 individuals who knew the resort from a previous stay had not been there for at least 2 years. Means and standard deviations of variables characterizing the study participants are provided in Table 1.

Procedure and Equipment

Individuals received an automatic BP monitor (Boso medicus PC from BOSO Ltd, Vienna, Austria) 3 weeks prior to the stay at the health resort and were instructed in its use. BP was measured by oscillogonometry via a cuff placed on the left upper arm above the elbow. They were asked to measure BP three times daily, before breakfast, before supper at around 6 p.m., and before going to bed in a sitting position after a 2-minute rest. The BP readings and the time of measurement were stored by the device and uploaded onto a PC. Home BP monitoring has been found to be a reliable approach in assessing BP. In addition, study participants received a diary to be filled out every morning throughout the duration of the study. The diary was also returned at the end of the study. Participants started keeping the diary and measuring BP exactly 21 days prior to their scheduled stay in Bad Tatzmannsdorf and continued data acquisition during their 21-day stay and 21 days after returning home. Study participants had personal contact to a study assistant, a health psychologist, at the beginning and end of the study, and at study midterm to sustain adherence to the study regime. For this study, only the data of the first 26 days of the study (home phase and the first 5 d of the stay at the health resort) were used.

Trip and Travel Destination

Study participants traveled to the health resort in the morning or at mid-day and arrived in the early afternoon. Travel days were Tuesday, Wednesday, or Thursday. Most individuals drove in their own car (58.8%) or were driven by family members (20.6%); some individuals used public transportation (20.6%). Average travel duration was around 83 minutes and did not significantly vary between types of transportation (p > 0.76). Travel was not experienced as stressful as assessed with a worded scale with a range of 1 to 4. Perceived travel strain was 1.2 (SD 0.4), 1.1 (SD 0.4), and 1.7 (SD 0.8) for driving oneself, being driven, or using public transportation, respectively, and also did not differ significantly between types of transportation (p = 0.06). The perceived travel strain measure is described in the variable section in more detail. The study lasted for slightly over a year, thus capturing travel during all seasons. The travel destination, Bad Tatzmannsdorf, is a small resort town (1,300 inhabitants) in a rural part of eastern Austria with
a spa treatment center, two rehabilitation centers, and several hotels encircling a large park. Spa therapy is a common form of treatment in Austria incorporating treatments such as massages, baths, mud packs, exercise treatment, and health counseling administered during a 3-week stay at a resort. The aim is to improve health especially in regard to chronic musculoskeletal pain and cardiovascular risk factors. The costs for spa therapy including the stay at the health resort are covered by public health insurance. Individuals participating in this study lived in a hotel.

Variables
A daily BP value was calculated as mean of the morning and evening BP readings after imputing missing values in both readings using linear interpolation. On average, 2.3% of the morning BP measurements and 11.1% of the evening BP measurements were missing. The correlation between morning and evening baseline BP was \( r = 0.84/0.69 \) (systolic/diastolic). High correlations between morning and evening BP measures \( (r = 0.90/0.88) \) previously have been reported in literature. The late afternoon measures were excluded due to frequent missing values, large differences in recording time and the potential of being affected to a greater extent by daily chores and work. The correlation of baseline home BP measurements and clinical BP assessment made on the first day of the study is \( r = 0.72/0.62 \), thus documenting an acceptable validity of the home BP measurement. The quality of sleep and mood were recorded in a diary on 7-point Likert scales. The phrasing was “last night, I slept very poorly/very well” and “today I am in very bad/in very good mood.” On average, 1.6% of the sleep or mood measures were missing. These again were imputed using linear interpolation. This format of single item measures was used on grounds of acceptability for participants, as the diary had to be filled out on a daily basis over 9 weeks. Single item self-report measures are used for the assessment of different aspects of health and well-being and are generally considered to have good reliability. The correlation of baseline quality of sleep and the average number of nocturnal awakenings reported at the onset of the study was \( r = 0.52 \), thus indicating some cross-validity of the used sleep scale. The correlations of baseline mood with the scales “negative mood” of a well-known standardized German quality of life questionnaire as well as with “burnout,” a well-known standardized measure of general well-being, was \( r = -0.43 \) and \( r = -0.56 \), respectively, indicating an acceptable validity for assessing general well-being. As a reference value for every-day home-based life, a baseline value (BL) was calculated as average of the 3-week period prior to the temporary change of residence. The first and last 3 days were excluded to correct for a possible novelty response to study participation and a possible anticipatory response to the upcoming change of residence. The effects of a change of location were investigated for the day prior to CoR (CoR−1), the CoR (CoR0, eg, travel day), and the first day at the new location (CoR1). The fifth day after the change of residence (CoR5) was used as a post-CoR reference value. Perceived travel strain was measured with a 4-point worded scale [“travel strain was very (4), rather (3), hardly (2), not at all (1) strenuous”].

Statistics
To test for the adequacy of the given sample size, a statistical power calculation was conducted using the power calculator provided by our University, imputing the baseline and average response values. The statistical power of the three significant variables was 0.26/0.36/0.90 (systolic BP/diastolic BP/sleep), indicating a small power for detecting differences in BP, but a large power for detecting differences in sleep. To test for the feasibility of using a parametrical statistical approach, the normal distribution of all four dependent variables (diastolic BP, systolic BP, quality of sleep, and mood) during pre-travel baseline and on the four single days around the CoR was controlled for visually on the basis of histograms. All distributions were found to be adequate. To analyze the effect of the CoR, a multivariate analysis of variance for repeated measures was calculated for the five time points BL, CoR−1, CoR0, CoR1, and CoR5, thereby comparing each of the days CoR−1 to CoR5 with the baseline value (BL) using so-called “simple contrasts.” Thus, four contrasts were calculated for every variable. The statistical significance of these comparisons (\( p \) values) is displayed in Table 2. All four outcome variables were analyzed simultaneously in the multivariate approach, thus following the suggestions of Drummond to use one global statistical test. Also, this approach controlled for the multiple comparisons calculated. To test for possible differences between morning and evening BP readings, average morning and evening BP responses (average of CoR−1, CoR0, CoR1 – BL) were compared using t-tests for paired samples. To test the association of the responses to the CoR with variables describing the study participants, their medical condition and travel, the correlation of the response values (average

| Table 2 | Effects of the change of residence |
|--------|----------------------------------|
|        | CoR−1   | CoR0    | CoR1    | CoR5    |
| Systolic BP | −7.3/15.9** | [−19.3/21.7] | [−17.2/18.2] | [−19.9/16.1] |
| Diastolic BP | −9.8/24.0** | [−11.3/23.1] | [−9.3/18.1] | [−14.7/14.4] |
| Quality of sleep | [−3.1/2.3] | [−4.5/2.3] | [−4.1/2.3]** | [−3.6/3.6] |
| Morning mood | [−3.6/2.1] | [−3.6/2.5] | [−2.5/2.1] | [−1.8/3.5]* |

Range of change (minimum/maximum) and statistical significance: comparison of baseline with CoR−1 (day before the change of residence), CoR0 (travel day, change of residence), CoR1 (first day at new residence), and CoR5 (fifth day at new residence, control day); BP = blood pressure; CoR = change of residence.

* \( p < 0.05 \), ** \( p < 0.01 \), *** \( p < 0.001 \).
Baseline values, ie, the average level of BP, perceived quality of sleep, and morning mood while individuals were at home pursuing their daily activities, were compared to the values on the days prior to, during, and after the change of residency (CoR\textsubscript{−1}, CoR\textsubscript{0}, CoR\textsubscript{+1}) as well as to the values 5 days after the CoR (CoR\textsubscript{+5}). These results are illustrated in Figure 1. The statistics and the range of change are provided in Table 2. Both systolic and diastolic BP's were higher on CoR\textsubscript{−1} compared to baseline. Diastolic BP remained increased throughout CoR\textsubscript{0} and CoR\textsubscript{+1}. Additional analyses revealed no differences between increases in morning and evening BP for either systolic or diastolic BP (p = 0.14, p = 0.40, respectively). The perceived quality of sleep was poorer during the first night at the new residence. The change of residence, however, did not affect mood. On the fifth day at the new residence (CoR\textsubscript{+5}), both diastolic and systolic BPs as well as the quality of sleep were non-significantly different from baseline and mood was improved compared to baseline.

The average response to the CoR did not correlate with any of the study participants’ characteristics (eg, age, sex, travel duration, and strain) except for occupational status (Table 3). Those retired showed a greater response in diastolic BP to the CoR than those occupationally active. A closer inspection of the data revealed that this was due to a lower baseline diastolic BP in those retired. The average systolic and diastolic BP responses to the CoR as well as the responses in

| Table 3 Correlation of average responses to the CoR with individual and travel characteristics |
|-----------------------------------------------|----------------|----------------|--------|--------|
| Age                                           | 0.09           | 0.06           | −0.12  | −0.17  |
| Sex (% men)                                   | −0.02          | −0.02          | −0.02  | −0.03  |
| Body mass index (kg/m\textsuperscript{2})     | 0.07           | 0.18           | −0.07  | −0.08  |
| Living with partner (no < yes)                | −0.03          | 0.01           | −0.04  | −0.04  |
| Formal education (years)                      | −0.16          | −0.02          | −0.08  | 0.07   |
| Retired (no < yes)                            | 0.17           | 0.31\textsuperscript{*} | −0.07  | −0.22  |
| Smoker (no < yes)                             | 0.12           | −0.09          | −0.23  | −0.08  |
| Chronic pain disorder (no < yes)              | 0.00           | −0.16          | −0.14  | 0.02   |
| Essential hypertension (no < yes)             | −0.06          | −0.16          | 0.20   | 0.14   |
| Antihypertensive treatment (no < yes)         | 0.01           | −0.15          | 0.11   | 0.06   |
| Baseline systolic BP > 140 mmHg               | −0.11          | 0.09           | 0.24   | 0.06   |
| Baseline diastolic BP > 90 mmHg               | −0.02          | 0.18           | 0.19   | 0.22   |
| Travel duration (minutes)                     | 0.07           | 0.09           | −0.14  | −0.26  |
| Strain of travel (scale 1–4)                  | −0.02          | −0.11          | 0.03   | −0.06  |
| Previous visit to travel destination (no < yes)| −0.16          | −0.18          | −0.15  | −0.20  |

Average response to CoR = average of CoR\textsubscript{−1}, CoR\textsubscript{0}, CoR\textsubscript{+1} − baseline; BP = blood pressure; CoR = change of residence.

\textsuperscript{*}p < 0.05.
sleep and mood, respectively, correlated significantly with each other ($r = 0.58$ and $r = 0.61$, respectively). However, BP responses did not correlate with responses in sleep or mood.

## Discussion

The study aimed at investigating travel-related effects of a temporary change of one’s living environment (i.e., temporary change of residence, CoR) on psychophysiological indicators of stress. On the basis of research in animals and humans regarding responses to novelty, we assume that a CoR will be associated with an increase of BP and a deterioration of mood and sleep.\(^6,12,15\) We chose to study CoR in a setting minimizing factors other than the CoR itself, e.g., travel stress and travel obligations, by studying individuals traveling to a health resort to receive spa therapy, a non-demanding, restorative undertaking. Indeed, travel duration was fairly short, on average 90 minutes and was non-stressful. Also, spa therapy is experienced as restorative and non-demanding and is associated with an improvement of mood and well-being.\(^39,40\) Thus, one can expect the CoR to be the primary source of a possible strain reaction around the time of travel.

Systolic and diastolic BP were increased on the day proceeding the travel, diastolic BP remained elevated on the travel day and the first day at the health resort. Both BP measures returned to baseline on day 5 of the stay. The increase of BP prior to the CoR most likely is due to travel anticipation. In experimental studies, short-term anticipation of situations requiring active coping have been found to be associated with increased cardiovascular activity.\(^41–43\) Our results indicate that anticipation also can have a more prevailing effect. An alternative explanation would be viewing the BP increase as a consequence of physical activity associated with travel preparations (e.g., packing). However, this seems unlikely considering the limited physical demands associated as well as the morning and evening BP assessment. The continued elevation of diastolic BP suggests increased cardiovascular arousal due to coping with the novel surroundings as found in experimental research.\(^19\) Evidence for increased cardiovascular activity in association with travel and a CoR previously has been found in a study on the prevalence of myocardial infarction during vacation, which was significantly more common during the first 2 days.\(^44\) Total average BP increases were 2 to 3 mmHg with no indication of morning–evening differences or heightened responses in certain subgroups. Thus, considering the small magnitude and the transient nature of the BP responses, these cannot be regarded as clinically significant. The return of BP to baseline on day 5 of the stay illustrates the transient nature of the CoR response, but also may be a preliminary reaction to spa-treatment, which tends to lower BP.\(^45\)

On the first night at the health resort individuals reported poorer sleep compared to baseline. This finding corroborates the “first-night effect” in sleep research.\(^12–14\) The present result indicates that this phenomenon is not limited to the sleep laboratory, but may be a common reaction to sleeping in any novel environment. However, verification with objective sleep measures would be necessary.

Morning mood did not respond to the CoR, contrary to our expectation. Several explanations can be put forth to account for this lack of response. First, mood may not be a measure sensitive to the psychological demands associated with a CoR. Possibly, other variables such as anxiety or perceived tension would have been more adequate. Second, a potential deterioration of mood related to the anticipation of and/or exposure to the novel environment may have been masked by positive expectations, known as the “rosy view” phenomenon, and the curiosity induced by novelty.\(^46,47\) At this point, a more detailed psychological mapping of the responses to a CoR seems warranted for future studies. The improvement of mood on the fifth day after CoR is presumably related to a respite from work and the corresponding psychological recovery.\(^40,48,49\)

The responses to the CoR were not associated with demographic, medical, or travel-related variables except for the retirement status, those retired showing a slightly larger diastolic BP response to the CoR. Whether individuals previously had visited the resort or not also did not affect the responses possibly due to the minimum of 2 years between the current and past visit. This indicates that the response is not restricted to identifiable subgroups.

Some limitations of this study deserve attention. The study does not allow determining whether the observed reactions are indeed a response to a change of residence or rather a response to a \textit{change of routine} associated with a change of residence. However, in both cases, novelty is the common denominator to which individuals react. Future studies will have to address this issue. The interpretation of the observed responses as stress-reactions is tentative as no specific psychological measures of stress were used. However, as reactions to novelty commonly are described as stress–responses in literature,\(^10,11,50\) we consider interpreting the findings as “stress–response” as appropriate. A selection bias cannot be ruled out as study participants were solely recruited from individuals planning a stay at the health resort. However, spa therapy being covered by health insurance in Austria, selection based on income or education is unlikely.

In conclusion, this study shows that a travel-related temporary change of residence (CoR) leads to a mild stress response in humans as documented by an increase in BP and a disruption of sleep. BP responded already on the day before CoR, indicating the effect of travel anticipation. Individual differences did not affect the response to any large extent. The findings have several implications. First, humans are sensitive to staying...
overnight looking for restoration should consider several day stays as the restorative potential of a single day may be dampened by the novelty response. Third, tourist providers possibly could decrease the novelty response by providing experientially accessible information so tourists can get a “feeling” for their destination beforehand. Fourth, vacation studies and studies on resort-based spa therapy should not rely on measures taken on the days immediately preceding or following the onset of the stay, as these measures could be distorted by the documented novelty response.

Declaration of Interests

The authors state that they have no conflicts of interest.

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