UNIVERSITÄT FREIBURG SCHWEIZ
UNIVERSITÉ DE FRIBOURG SUISSE

DEPARTEMENT FÜR PSYCHOLOGIE
DÉPARTEMENT DE PSYCHOLOGIE

A History of Research Conducted in Daily Life

Peter Wilhelm & Meinrad Perrez

June, 2013

SCIENTIFIC REPORT Nr. 170

Department of Psychology

University of Fribourg, Switzerland

Keywords

History, Historical Review,

Diagnostic Methods, Ambulatory Assessment, Ecological Momentary Assessment, EMA, Everyday Life, Real Life,

Diaries, Electronic Diaries, Experience Sampling Method, ESM,

Psychophysiology, Physiological Monitoring, Cardiovascular Activity, Ambulatory Monitoring, Holter Monitoring, Ambulatory Electrocardiography, Space Medicine, Bio-Telemetry, Ambulatory Blood Pressure Assessment,

Physical Activity, Movement Monitoring, Posture Monitoring, Accelerometry, Actigraphy, Pedometer,

Location Tracking, Global Positioning System, GPS, Electronic Monitoring, Electronic Tagging, Electronic Bracelets

Please cite this review as follows:

Wilhelm, P. & Perrez, M. (2013). *A history of research conducted in daily life* (*Scientific Report Nr. 170*). Fribourg, Switzerland: Department of Psychology, University of Fribourg, Switzerland. Retrieved from: http://www.unifr.ch/psycho/site/assets/files/klinisch/Wilhelm%20&%20Perrez%20(2013).%20A%20history%20of%20research%20coducted%20in%20daily%20life.pdf

Preface

This is an extended and updated version of a historical review on research conducted in daily life (Wilhelm, Perrez, & Pawlik, 2012), that we wrote for the *Handbook of Research Methods in Daily Life* (Mehl & Conner, 2012). It contains additional chapters on ambulatory blood pressure assessment (chapter 3.6) and location tracking (chapter 5), that were not published in Wilhelm et al. (2012).

We thank Kurt Pawlik for carefully reading most parts of this review during different stages of its development, for his comments and for improving the English. We also thank Thomas Kubiak and Jochen Fahrenberg for their comments on this report, and Michael Myrtek for his remarks on the section about physiological monitoring. We are very grateful to Tamlin Conner and Ian Law who edited the English of the final version of this report and to Jan Paul who checked the citations and references for completeness and accuracy.

Correspondence concerning this report should be addressed to Peter Wilhelm, Department of Psychology, University of Fribourg, Rue de Faucigny 2, 1700 Fribourg, Switzerland. E-mail: Peter.Wilhelm@unifr.ch

Contents

1 Focus of this Historical Review on Research Conducted in Daily Life

The aim of this historical review is to highlight the origins and important developments of major approaches for conducting research in daily life. Our focus is on different methods that have often been combined under the umbrella terms *Ecological Momentary Assessment* (EMA; Stone & Shiffman, 1994; Stone, Shiffman, Atienza, & Nebeling, 2007; Trull & Ebner-Priemer, 2009) or *Ambulatory Assessment* (Fahrenberg, 1996a; Fahrenberg, Myrtek, Pawlik, & Perrez, 2007; Trull & Ebner-Priemer, 2013).

Characteristic of these methods is that people's current experience and behavior is assessed repeatedly (or even continuously) in their natural environments, without or with only minimal latency. Ambulatory Assessment / Ecological Momentary Assessment thereby avoid recall biases which seriously impair conventional retrospective questionnaire or interview reports (Conner & Barrett, 2012; Fahrenberg et al., 2007; Reis, & Gable, 2000; Schwarz, 2007, 2012; Trull & Ebner-Priemer, 2009, 2013).

In addition, it allows capturing fluctuations of naturally occurring experience and behavior across time (Bolger, Davis, & Rafaeli, 2003; Fahrenberg et al., 2007; Shiffman, Stone, & Hufford, 2008; Trull & Ebner-Priemer, 2009, 2013). Thus, processes that occur in time frames of hours, days, or even weeks, that are difficult or even impossible to assess in laboratory environments, can be studied using these methods.

Finally, Ambulatory Assessment aims to ensure the *ecological validity* of research. Ecological validity is usually understood as the degree to which the results of a study can be generalized to people's behavior in their *real* or *everyday life* (see also Fahrenberg et al., 2007; Hammond, 1998; Kaplan & Stone, 2013; Trull & Ebner-Priemer, 2013; Reis, 2012; Tunnell, 1977; Wilhelm & Grossman, 2010). [1]

---

[1] The term ecological validity was coined by Egon Brunswik (1947, 1955), who however gave it a different meaning (see also Hammond, 1998). In Brunswik's theorizing, ecological validity refers to the probabilistic relationship between the organism and its environment in the framework of his *lens model*. What researchers call ecological validity today, Brunswik (1955, p. 205) labeled *ecological generalizability*. It can be achieved through *representative design,* which means that measures are repeatedly taken in different natural situations that are representative for the environment.

It would hardly be possible to give a comprehensive historical overview. Therefore, we have narrowed our focus on the development of four major approaches used to conduct research in daily life: 1) Diaries and related methods to record everyday experiences and behaviors, 2) (psycho)physiological monitoring of heart activity, and blood pressure 3) monitoring of physical activity and body movements, and 4) tracking of the current location. For these approaches, we have tried to capture their technological beginnings, the circumstances under which they were first used, and the factors that led to their further refinement. For more recent stages of research, we give selected examples or refer to literature reviews.

2 Self and Other Records in Daily Life

Diaries as written records of current events and experiences have a long history, reaching back to antiquity. For example, Marcus Aurelius' (121-180) *Meditations* are at least in part records of daily reflections. Five different functions of diaries can be distinguished: a) the recording of historically significant events (e.g., the journal of Arthur Bowes Smyth, 1787-1789, on Australian settlement), b) the logging of incidents in seafaring and expeditions (e.g., the journal of Christopher Columbus), c) the retention of private daily life experiences (e.g., the journal of Samuel Pepys, 1660-1669), d) the logging of professional incidents as it is common in psychotherapy, and e) the recording of observations or experiences for scientific documentation and research.

Charlotte Bühler (1922) and Gordon Allport (1942) proposed the analysis of private diaries as object of research to obtain insights into people's functioning during daily life. However, in this section, we focus on diaries as a scientific research method, and show how concerns about the validity of records led to an increase in structure and methodological rules. We begin this retrospective review with narrative observation diaries, which became popular more than 200 years ago, and end it with a review of experience sampling and contemporary electronic systems for momentary assessments.

2.1 Narrative observation diaries in developmental research

At the end of the 18th century, scholarly fathers began to publish diary records about the development of their children (e.g., Tiedemann, 1786; see Wallace, Franklin, & Keegan, 1994). In 1877, Darwin published a report on the development of sensory perception and emotion expression, based on diary notes he took 37 years before. During the first two years of his son's life, he "wrote down at once whatever was observed" (p. 285). In addition, he recorded the infant's responses to different stimuli, which he presented to test the development of particular reflexes (e.g., eye blinking) and reactions (e.g., fear).

Investigating the development of language, the German physiologist William Tierry Preyer (1889/1882) formulated a set of rules to which he adhered "strictly, without exception", to achieve "the highest degree of trustworthiness" (p. 187). He demanded that the same child should be observed at least three times every day during the first thousand days of his life. "Every observation must immediately be entered in writing in a diary that is always lying ready" (p. 187). In addition, "every artificial strain upon the child is to be avoided, and the effort is to be made as often as possible to observe without the child's noticing the observer at all" (p. 187). It would rather be difficult to realize this scientific rigor in a contemporary research project.

Later, developmental psychologists such as Clara and William Stern (1900-1918) and Jean Piaget also wrote psychological diaries on the development of their children. Based on his diary records, Piaget (1926) generated his ideas on the developmental stage theory, which he then tested in experiments.

Karl Bühler (1921) saw the strength of using unstructured observation diaries to gain an overview on phenomena in a new domain, which then inspires research questions and hypotheses. Characteristic of these early observation diaries was that they were narrative, and there were no common methodological rules on how observations should be performed and recorded. In the 1920s and 1930s researchers began to agree on such rules, which Olson and Cunningham (1934) summarized to five general principles: 1) there is an eye witness, 2) who observes behavior that is defined in terms of overt actions, 3) during a defined unit of time, 4) repeated for a stated number of times. 5) From these observations individual scores are computed according to defined rules. In addition, Olson and Cunningham (1934) proposed procedures to determine the reliability and validity of observations (see also Arrington, 1943).

Space does not permit us to outline the further development of observation methods. However, the refinement of techniques to observe people's behavior in their daily lives has at least been as diverse and sophisticated as that for self-recording methods (e.g., Arrington, 1943; Barker & Wright, 1951, 1955; Benson, 2010; Intille, 2007; Mehl, Pennebaker, Crow, Dabbs, & Price, 2001; Mehl & Robbins, 2012; Mehl, Robbins, & Deters, 2012; Proshansky, Ittelson, & Rivlin, 1976; Rosander, Guterman, & McKeon, 1958; Scherer & Ceschi, 1997; Webb, Campbell, Schwartz, & Sechrest, 1966).

2.2 Early self-record studies

In medical case studies published in the early 20th century, patients sometimes reported their symptoms and medically relevant aspects of their behavior in diaries (e.g., Favill & Rennick, 1924, as cited in Stone et al., 2007; Stone, 1908). With an increase in information gathered, the need to structure and standardize the records increased to facilitate analyses and to ensure comparability of records across situations and between persons.

An example of an early systematic self-record of current experiences that was even combined with the assessment of task performance under daily life conditions was given by Hugo Münsterberg (1892, 1908), a pioneer of Applied Psychology. Convinced that real life affective states and emotions could not be adequately induced in the laboratory, he kept a diary over nine months to record his mental and affective state three to five times a day. "Whenever daily life brought [him] into a characteristic mental state, such as emotion or interest or fatigue or anything important to the psychologist", Münsterberg (1908, p. 71) began to record his current state and performed about twenty experimental tasks, which took him half an hour time. In one task, he had trained himself to measure from memory a distance of 10 and 20 cm with his fingers on a small instrument in his pocket.

Analyzing his diary Münsterberg identified three basic affective dimensions to describe the different qualities of feelings he had experienced (pleasure—displeasure, excitement—depression, gravity—hilarity). In addition, he found that he overestimated the distances measured with his fingers, when he was feeling excited, and underestimated them, when he was feeling depressed. Later, Münsterberg (1908) suggested that this task in combination with the assessment of physiological reactions might be of use as a "lie detector", in order to assess a witness's true emotional state.

Since the 1920s, diaries have been increasingly used in group studies. To investigate individual differences in sense of humor, Kambouropoulou (1926) asked seventy female students to write down the things they laughed about each day for one week. Based on qualitative and quantitative analyses of the humor diaries, Kambouropoulou found substantial consistency in the types of humor experienced across situations.

Already in 1917, Flügel (1925) had reported —according to our knowledge— the first EMA study at the conference of the British Psychological Society. Flügel had severe doubts about the reliability of retrospective reports of states of mind, and therefore argued for momentary assessment. He trained friends and volunteers to apply the method of introspection in their daily lives and record their current affective state every hour for at least 30 days. They rated their degree of pleasure on a bipolar scale and gave a description of their current feelings. Based on data of nine participants, he found a predominance of pleasure over displeasure. However, individual differences were considerable, and those participants who experienced more extreme feelings were also less happy in general.

In a multi-method feasibility study, Hunscher, Vincent, and Macy (1930) investigated the relation among physiological, psychological, and social factors and the secretion of breast milk. During three years, three lactating women measured the quantity of the milk they produced and rated their mood on twelve bipolar rating scales every day. Moreover, a female observer lived two days each month (for one year) in their homes to weigh the food eaten by the women, and to note the women's activities and emotional reactions. Interpreting graphic representations of one mother's data, the authors concluded that the analysis of a larger number of such records would allow proofing the hypothesis that emotional experiences and the quantity and quality of milk produced are related.

To investigate the physical, mental, and behavioral changes accompanying the menstrual cycle, McCance, Luff, and Widdowson (1937) asked 167 women to complete a structured daily diary for six months. They found that menstrual cycles varied within every woman, which contradicted results of previous research based on questionnaire methods. Moreover, such discrepancies also occurred in their own study, when they compared women's generalized responses given in an initial questionnaire (e.g., about the regularity of menstruation) with their daily records. Plotting results over days of the cycle, they could show that the intensity of sexual desire and incidence of sexual intercourse were associated with the menstrual cycle, as were feelings of fatigue, depression, irritability, and the tendency to cry. In addition, the incidence of abdominal pain, back pain, and headache largely increased with the onset of the menstrual flow.

2.3 Diaries in econometrics and time budget research

Already by the end of the 18th century, income and expenses of worker's families were recorded with housekeeping books in order to study their material living conditions (Szalai, 1966). Still to this day, such studies are conducted by econometrists, with intensive methodological research on expenditure diaries (Sudman & Ferber, 1971).

At the beginning of the 20th century, interest grew in how people – especially those from the working class - spend their time. In early studies interviews and questionnaires were used to obtain global estimates for time spend for work, housework, and leisure activities (e.g., Bevans, 1913; see also Szalai, 1966).

Unsatisfied with the validity of retrospective reports, Nelson (1933, as cited in Fox, 1934) designed a structured diary form to assess activities performed in half-hour units. Almost 500 female employees completed the diary for three consecutive days, and data later analyzed by Thorndike (1937) showed that they spent about 48 hours per week for living (including transportation), 24 hours for personal care, eating, and shopping, and 33.5 hours for pleasure. Nelson commented that although this would still be a “meager sample of any one individual’s time,[…] it is probably a more true picture of the division of a day […] than innumerable questionnaires would or could ever elicit” (Nelson, 1933, p. 4, as cited in Fox, 1934, p. 495).

To investigate how gender, age, and socioeconomic factors influenced children’s leisure activities, Fox (1934) slightly adapted Nelson’s diary and gathered data from 372 boys and girls living in different suburban areas. Among other results, Fox found that girls had more home duties and therefore less leisure time than boys. Moreover, children living in the poorest suburb spent more time in paid work and work around the house, but less time in leisure activities than did children living in the wealthier areas. Similar studies followed in different countries (see Szalai, 1966).

After World War II, 24-hour diaries to assess the timing and frequency of activities performed during a day were used in large population samples (e.g., 12,000 persons in a Hungarian micro census in 1963; Szalai, 1966). This method was also used in the multinational comparative time budget project that was initiated in 1964 and supported by the UNESCO, which coordinated research activities in twelve countries from the East and West, including the U.S.A. and the U.S.S.R. (Szalai, 1966, 1972). Since 1985, statistical agencies in more than 15 countries have gathered national time use data with similar methods (Harvey, St. Croix, & Reage, 2003).

2.4 Diaries in health research and the investigation of recall errors

In a review on health diaries, Verbrugge (1980) cited the Baltimore Morbidity Survey (Downes & Collins, 1940) as the first epidemiological study in which health diaries were used. In this study, interviewers visited 1796 white families every month for one year. In order to provide a memory aid and to increase the accuracy of the information gathered by the interviewers, one family member (usually the mother), was in charge of keeping a diary form on a calendar basis, recording onset and duration of illness, medical treatment, and other information for every family member. One interesting result of this study was that people who moved in or out of the area during the time of the study (27%) were more often ill and spent more days in hospital, than those who did not move.

Although various researchers had raised doubts regarding the accuracy of retrospective reports, more systematic research on this topic only began in the 1950s. Responsible for the development of a valid method to assess illness data on a state wide base in California, Allen, Breslow, Weissman, and Nisselson (1954) conducted a method study in which they compared interview and diary data obtained in 400 households. Interviewers asked respondents, who had kept an illness diary for the last month, whether an illness had occurred for any household member a) the day before the interview and b) during the last 30 days. For medically attended illnesses, differences between diary and interview estimates were small, but for medically unattended illnesses, results differed substantially. Diary entries for the last thirty days resulted in higher illness estimates than those based on the interview. This was largely due to the fact, that “minor” illness was reported in the dairy, but not in the interview. Allen et al. (1954) concluded that the differences found between the two methods were “clearly related to errors of memory” (p. 922). Their results were confirmed in other health studies conducted in the 1960s and 70s (e.g., Roghmann, & Haggerty, 1972; Verbrugge, 1980).

However, Allen et al. (1954) were not the first to investigate recall errors in remembering daily life events. Already in 1930, Thomson had investigated whether people tended to forget the unpleasant events faster than the pleasant events, which was a hypothesis derived from Freudian theory. Among other tasks, the 29 participants kept a diary for five days and recorded pleasant and unpleasant events they had experienced. Two weeks later, they remembered about one third of both the pleasant and unpleasant events they had recorded. After four weeks, they remembered one fourth of the pleasant but only one sixth of the unpleasant events. Thomson (1930) could replicate the latter finding with a sample of 101 pupils who recorded events for one day. In sum, her results suggest that positive events get more readily remembered.

A couple of years later Pyles, Stolz, and Macfarlane (1935) found a tendency to forget negative experiences, too. They compared 225 mothers' retrospective reports about the birth and development of their child (given when the child was 21 months) with reports gathered by public health nurses every 3 months. Mothers tended to minimize or forget problems during pregnancy, labor, and development of their children. In addition, they had a precocity bias in remembering when their children had their first teeth or walked.

This early, in part forgotten, work laid the foundation for subsequent research into the differences between momentary and retrospective reports that have been intensively investigated in experiments (e.g., Redelmeier & Kahneman, 1996; Redelmeier, Katz, & Kahneman, 2003) and ecological momentary assessment studies (e.g., Hedges, Jandorf, & Stone, 1985; Käppler & Rieder, 2001; Smith & Safer, 1993; for reviews see Bernard, Killworth, Kronenfeld, & Sailer, 1984; Conner & Barrett, 2012; Fahrenberg, Hüttner, & Leonhart, 2001; Gorin & Stone, 2001; Robinson & Clore, 2002; Schwarz, 2007, 2012). The fact that momentary assessment leads to less distorted information by avoiding recall biases (and minimizing naïve theories and heuristic processing) has become a major legitimization for the use of these methods (e.g., Bolger et al., 2003; Ebner-Priemer & Trull, 2009; Fahrenberg et al., 2007; Shiffman, Stone, & Hufford, 2008; Trull & Ebner-Priemer, 2009, 2013).

2.5 Self-monitoring in behavior therapy

In the 1960s, the influence of behaviorism declined and cognitive approaches in different areas of psychology, including psychotherapy, became popular. In the context of cognitive behavior therapy, disorder-specific diaries and *self-observation-procedures* have been developed for applied and research purposes (e.g., Lewinsohn & Atwood, 1969; see Hufford & Shields, 2002 and Thiele, Laireiter, & Baumann, 2002, for an overview).

In an etiologically motivated diary study, Lewinsohn and Libet (1972) let patients and controls rate their positive activities and mood at the end of each day over a period of one month. They found that both measures correlated within individuals across time, which they interpreted as a confirmation of the theoretical claim that the intensity of depression is due to a lack of positive reinforcement. Lewinsohn and Graf (1973) replicated this finding and found that depressed participants reported less positive activities than psychiatric or normal controls. Later Sanchez and Lewinsohn (1980) showed with cross lagged analyses for each patient that the current day's assertive behavior predicted level of depression the next day, but current day's level of depression did not predict next day's rate of assertive behavior.

Following an event-contingent protocol, patients in research and practice have been instructed to record particular target behaviors whenever they occur. In addition, the situational circumstances, accompanying cognitions (e.g., dysfunctional thoughts and self-instruction), and feelings have been recorded in order to obtain information about situational antecedences and consequences of the behavior (e.g., Beck, Rush, Shaw, & Emery, 1979). Since the 1980s specific diaries have been developed for many psychological disorders and health related problems (Thiele et al., 2002; Piasecki, Hufford, Solhan, & Trull, 2007).

Because clinical psychologists have been interested in behavior modification, they were also motivated to find out in what way reactivity effects of self monitoring procedures could be used to facilitate desired behavior changes (e. g. Bayer, 1972; Kazdin, 1974). In a field experiment, McFall (1970) for example demonstrated that cigarette consumption increased in a group of students who counted the cigarettes they had smoked, whereas consumption decreased in students who counted occasions they considered smoking, but resisted. McFall and Hammen (1971) further showed that motivating participants to quit smoking and let them monitor their smoking behavior (with a wrist worn event counter; see Lindsley, 1968), reduced smoking to the same degree as reported that from stop-smoking programs. Supporting these results, Kazdin (1974) found in a series of experiments that the act of self-monitoring alone changed behavior (thus producing reactivity), but the valence of the target behavior determined the direction of change. For a further discussion of research on reactivity see Stern (1986) and Barta, Tennen, and Litt (2012).

2.6 Momentary assessment: Different designs for data sampling

Wheeler and Reis (1991), who acknowledge Klingler (1971) for this classification, distinguish three strategies to sample protocols:

- interval contingent protocols—at predetermined times, and usually in regular intervals;
- signal-contingent protocols — at fixed or random times indicated by a signal device;
- event contingent protocols —when a predefined event occurs.

Examples for interval contingent protocols are diaries completed at the end of a day (e.g., Fox, 1934; Kambouropoulou, 1926), the observation of feelings at every other hour (Flügel, 1925), or the recording of snippets of ambient sounds every 12 minutes (Mehl et al., 2001).

In the following, we briefly review *random signal contingent* and *event contingent* sampling strategies. (For a further discussion of designs in research on daily life see Bolger, Davis, & Rafaeli, 2003; Conner & Lehman, 2012; Reis & Gable, 2000; Shiffman, 2007; Wheeler & Reis, 1991).

2.6.1 Random samples of settings, situations, experiences, and behaviors

In the field of Psychology, the idea to sample situations at random moments goes back to Egon Brunswick (1943, 1955). When situations (or stimuli) are sampled at random from a universe or, in Brunswik's terms, an *ecology of situations*, they are representative for this universe and thus ecologically generalizable. However, already in the 1930s the British Statistician Tippett had introduced the *Snap Reading Method* in industry: Machine operators in a textile factory were observed at random intervals in order to estimate the percentage of time machines were idle. Under the label *work sampling*, this method was then applied to investigate workers' and employees' activities with the aim to enhance efficiency (Lorents, 1971; Rosander et al., 1958). The work sampling method is, however, less suited for the evaluation of higher level jobs, because externally observable behaviors are rather less relevant. Therefore, organizational psychologists began to let employees self-record their activities at random times or when predefined activities occurred (e.g., Burns, 1954).

From six randomly signaled self-record studies, reviewed by Lorents (1971), the first was published in 1964 by Hinrichs, who investigated communication activities of 192 technical employees. Each employee was given an alarm watch and a randomly determined time schedule on which times were listed when records should be given. These times—five each day, for eleven workdays—had been randomly determined in advance. At the proposed time participants completed questions and set the alarm watch to the next time proposed by the schedule. A couple of years later, pocket-size devices to give random alarms were used to investigate university faculty members activities (Lorents, 1971) or adolescents' spontaneous thoughts, sexual fantasies, and daydreams (Klingler, 1971). Hurlburt and colleagues continued the study of thoughts in patients (Hurlburt & Sipprelle, 1978) and students (Hurlburt, 1979; see Hurlburt & Heavey, 2004).

Parallel to these applications, Csikszentmihalyi and colleagues developed a similar approach, which has become famous under the label *Experience Sampling Method* (ESM). Interested in “flow” experience, they first asked participants to keep diaries and write down in the evening what they had done and what they had enjoyed most during the day. However, participants’ reports seemed to be written according to scripts and did not show much discrimination (Hektner, Schmidt, & Csikszentmihalyi, 2007, p. 7). Looking for a more satisfying approach, they found the solution in providing their participants with beepers that were available for medical doctors. Participants were asked to complete questions whenever the beeper—which was activated at random intervals—gave a signal.

Csikszentmihalyi, Larson, and Prescott (1977) first used this method to investigate 25 adolescents’ everyday experiences and activities, beeping them five to seven times a day for one week. They found that adolescents spent most of the time talking with peers or watching TV, but they felt better when they were talking with peers. In later studies, momentary sampling schedules have been varied. For example, investigating the consistency of feelings across time and situations, Diener and Larsen (1984) used a programmable wrist watch to signal students twice a day for six weeks to complete a mood scale.

Meanwhile, ESM has been used in hundreds of studies, with adolescents, students, employees, couples, families, and psychiatric patients, from different social and cultural backgrounds to investigate daily life activities and experiences and how they unfold in time (e.g., Brandstätter, 2007; Csikszentmihalyi & Hunter, 2003; de Vries, 1992; Fleeson & Noftle, 2012; Hektner et al., 2007; Hektner, 2012; Hoppmann & Riediger, 2009; Koval & Kuppens, 2012; Larson & Richards, 1994; Myin-Germeys, 2012; Oorschot, Kwapil, Delespaul, & Myin-Germeys, 2009; Palmier-Claus et al., 2011; Scollon, Kim-Prieto, & Diener, 2003; Tov & Scollon, 2012; Wichers et al., 2007).

2.6.2 Event contingent sampling of self-records

Münsterberg’s (1892, 1908) self-study is the earliest example of an event contingent sampling protocol, we are aware of. He considered the event to be a rather vaguely defined subjective experience: “A characteristic mental state, such as emotion or interest or fatigue or anything important to the psychologist”(Münsterberg, 1908, p. 71).

Interested in the communication activities and interactions of executive personal in a company, Burns (1954) let four managers record their interaction-partners and activities any time they were communicating during working hours, over a five week period. One result was, that almost half of the interactions took place within the executive group, whose members stayed “physically as well as socially […] inside the walls of their office” (Burns, 1954, p. 96). Wheeler and Reis (1991) acknowledged that Burns anticipated later attempts to capture social interactions.

More famous than Burns’ became Wheeler and Nezlek’s (1977) approach. They instructed participants to record every interaction that was longer than 10 minutes on a brief response sheet (*Rochester Interaction Record*) for two weeks. In the first study they focused on gender differences and found that novice female students socialized more and used their best friend (same sex) more than male students, to cope with the social stimulation associated with beginning to study. However, about six months later, these gender differences had disappeared.

Later, Perrez and Reicherts for example (1987, 1992) were unsatisfied with the common attempts to assess stress and coping reactions retrospectively (e.g., the Ways of Coping Checklist; Folkman & Lazarus, 1980). To capture feelings and cognitions immediately, they instructed participants to complete questions whenever they had experienced a stressful event (see chapter 2.7).

Remarkable is also Myrtek’s (2004) approach, who defined an increase in non-metabolic heart rate as the event that triggers the self-recording (see chapter 3.4). As already mentioned, event contingent recording plays an essential role in clinical research and practice (for a more extensive review of event contingent protocols, see Moskowitz & Sadikaj, 2012).

2.7 Electronic devices to record current experience and behavior in daily life

Up to the 1980s, experiences and behaviors were recorded through paper and pencil questionnaires. Such protocols allowed the assessment of information temporally closer to target events or to particular subjective states, if the subject was committed enough to follow the instructions. Some doubts about the protocol fidelity and technical advancements stimulated the use of portable computers to improve the quality of data assessed in daily life.[2]

Pawlik and Buse (1982) were the first to develop a computer-assisted system for ambulatory psychological assessment in cooperation with a hardware company. In later generations of devices, Buse and Pawlik, (1996, 2001; Pawlik & Buse, 2003) further added psychometric tests to obtain objective measures of current mental activation and performance outside the laboratory. In addition, finger pulse could be measured. In a series of studies, they assessed high school students' mood, settings, activities, and test-performance, to investigate the degree of cross-situational consistency and personality differences under field conditions (Buse & Pawlik, 1996, 2001; for another realization of ambulatory cognitive performance testing see Totterdell & Folkard, 1992).

To obtain event-contingent samples of stressful events experienced during daily life Perrez and Reicherts (1987, 1992, 1996) developed a computer-assisted recording system (COMRES) using the first generation of handheld computers (Sharp PC-1360) and available BASIC software. Whenever a participant experienced stress, he or she activated the device and entered information about the nature and content of the stressor, his or her affective response, appraisal of the situation (e.g., perceived controllability, ambiguity), and coping response. The COMRES was adapted to assess psychological stress in intensive care units (Malacrida, Bomio, Matathia, Suter, & Perrez, 1991), and social support in daily life (Baumann, Thiele, Laireiter, & Krebs, 1996; Perkonigg, Baumann, Reicherts, & Perrez, 1993).

---

[2] Already in the 1970s Bernard and Killworth conducted several studies using computers to investigate communication in social networks (see Bernard et al., 1984). Although computers were not portable, they investigated retrospection effects during daily communication. In a remarkable study. 57 participants exchanged messages over five months using the Electronic Information Exchange System (EIES), a precursor of e-mail communication. The "day-to-day communication network" and the "whom-to-whom traffic" was automatically recorded. In addition, participants answered questions regarding their daily communication. Results showed that participants did not accurately remember with whom and how often they communicated. Bernard, Killworth, and Sailer (1982, p. 62) concluded: "We feel that it is vital in any field to have accurate (not only reliable) data. It is virtually impossible to develop a theory for any process unless one can obtain accurate data about that process. This must be just as true for human communications (and interactions in general) as for black holes, DNA molecules, or the movement of tectonic plates."

Building on this experience the Fribourg research group then developed to our knowledge the first computer assisted diary system to assess the current affective and physical state, conflicts, coping (including intra- and interpersonal emotion regulation), and social cognitions simultaneously in fathers, mothers, and children (FASEM-C = computer assisted FAmily SElf Monitoring system; Perrez, Berger, & Wilhelm, 1998; Perrez, Schoebi, & Wilhelm, 2000; Perrez et al., 2005). With the FASEM-C symptom reporting (Michel, 2007), emotional states (Wilhelm, 2001), emotional transmission (Schoebi, 2008), empathic inference (Wilhelm, 2004; Wilhelm & Perrez, 2004), causal attributions (Perrez, Wilhelm, Schoebi, & Horner, 2001), intra- and interpersonal coping, and emotion regulation in couples' and families (Debrot, Cook, Perrez, & Horn, 2012; Perrez & Schöbi, 2001; Schoebi, 2004; Schoebi, Wang, Ababkov, & Perrez, 2010) have so far been studied. Other recent contributions of the Fribourg research group were concerned with the refinement of the assessment of mood and affective states in daily life (Reicherts, Salamin, Maggiori, & Pauls, 2007), and psychometric properties related to such assessment (Wilhelm & Schoebi, 2007).

Computer-assisted diary applications have also been developed by other research groups to study phenomena such as anxiety (Taylor, Fried, & Kenardy, 1990); pain (Smith & Safer, 1993); sleep (Totterdell & Folkard, 1992); smoking and drinking behavior (Shiffman et al., 1994); symptoms of asthma (Hyland, Kenyon, Allen, & Howarth, 1993), migraine attacks (Sorbi, Honkoop, & Godaert, 1996), eating disorders (Munsch, Meyer, Milenkovic, Schlup, & Wilhelm, 2009; Norton, Wonderlich, Myers, Mitchell, & Crosby, 2003), and to obtain current contextual and activity information relevant for psychophysiological studies (e.g., Fahrenberg, 1996b, 2001; Myrtek, Brügner, & Müller, 1996a, see also Hufford & Shields, 2003, for a comprehensive review on electronic diaries).

For most of such applications, computer programmers had to write the software, which was time consuming and costly. Therefore, the next generation of technology was advanced by flexible software packages that allowed researchers to design their applications on a handheld device without additional support of programmers (e.g. MONITOR, Fahrenberg, et al., 2001; the Experience Sampling Program [ESP], Feldman Barrett & Barrett, 2001; for a recent reviews see Ebner-Priemer & Kubiak, 2007). In a current review, Kubiak & Krog (2012) predict that handheld computers will soon be succeeded by generic devices, such as internet-enabled smartphones, which support online communication and access to internet resources.

2.8 Assessing and controlling compliance with electronic devices

The introduction of handhelds has had many advantages. For example, branching of questions is easily possible, records have an electronic data format, signal options are available, and response times can be stored. Another useful feature is the ability to control participants' compliance with timing. Compliance has been an issue of concern since the early use of paper diaries, because any delay in responses introduces recall errors, thus impairing the quality of the data. When handhelds (or other electronic devices) are used, researchers can control whether participants adhere to the instructions and complete questions when they are supposed to complete them (e.g., after receiving a signal).

Several studies have investigated whether the type of record used (paper vs. electronic) affects compliance. Hyland et al. (1993) let asthma patients complete questions on a paper diary and on a handheld twice daily for 14 days. They did not find significant differences between the two versions, but more observations were missing in the evening than in the morning, and also more retrospective entries were made in the evening. Hank and Schwenkmezger (1996) used a within subject design (6 times per day over 8 days in each condition) to compare electronic and paper diaries. They found that more records were completed when the paper version was used, and concluded that in the paper diary condition participants pretend a high compliance by disregarding the instruction (e.g., through hoarding and backfilling records).

This claim was then confirmed in a well conducted experiment by Stone, Shiffman, Schwartz, Broderick, and Hufford (2002). They assigned 80 patients with chronic pain to complete 20 questions three times a day for three weeks either using an electronic diary or a paper diary. Unbeknownst to participants, the paper diaries were fitted with photosensors that unobtrusively recorded when a particular page was opened and closed. Actual compliance (less than a 30 minute delay) was 94% when an electronic diary was used. In contrast, participants using the paper diary reported 90% compliance, but their actual compliance, as measured by the photosensor, was only 11 %, and hoarding and backfilling of answers was common.

To modify Stone et al.'s (2002) conclusion that the validity of paper diaries is in question, Green, Rafaeli, Bolger, Shrout, and Reis (2006) presented data from three studies to show that, under certain conditions, results gained with both methods were not substantially different. Although this led to a further debate (see Bolger, Shrout, Green, Rafaeli, & Reis, 2006), the use of electronic devices to assess self-records in daily life has become the standard for most applications.

2.9 Ambulatory electronic systems to modify behavior

In clinical and health psychology, handhelds have been applied to support behavior modification, since the 1980s, for different disorders such as obesity (Burnett, Taylor, & Agras, 1985; Taylor, Agras, Losch, Plante, & Burnett, 1991), bulimia nervosa (Norton et al., 2003), panic attacks (Newman, Kenardy, Herman, & Taylor, 1996, 1997; Kenardy et al., 2003), generalized anxiety disorders (Newman, Consoli, & Taylor, 1999), social phobia (Przeworski & Newman, 2004), or nicotine addiction (Carter, Day, Cinciripini, & Wetter, 2007). Based on the current information entered by the patient, systems were programmed to provide useful basic information, give immediate feedback, suggest exercises, or remind the use of more functional coping strategies. More recent approaches have used mobile phone systems in combination with internet platforms (Carter, et al., 2007; Sorbi, Mak, Houtveen, Kleiboer, & van Doornen, 2007; for reviews of recent approaches see Kaplan & Stone, 2013; Trull & Ebner-Priemer, 2013).

Moreover, various systems have been developed, for example, to give children with attention deficit hyperactivity disorder feedback on their current motor activity Schulman, Stevens, & Kupst, 1977; Tryon, Tryon, Kazlausky, Gruen, & Swanson, 2006), or to change breathing patterns in patients with anxiety disorders (Meuret, Wilhelm, Ritz, & Roth, 2007). In behavior medicine ambulatory feedback systems have been introduced for example to train patients' perception of early symptoms of an asthma attack (Leopold & Schandry, 2001) or hypoglycemia (Kubiak & Hermanns, 2001; Kubiak, Hermanns, Schreckling, Kulzer, & Haak, 2004).

3 Ambulatory Psychophysiological Monitoring of Cardiovascular Activity

In this section, we review the development of ambulatory monitoring of cardiovascular activity. In particular we focus on heart rate (HR) and blood pressure, because both are major indicators of ergonomic, mental, and emotional demands, which have since long been measured in daily life. Many other physiological measures have been assessed in daily life too, such as skin conductance (Boucsein, 2012; Boucsein, Schaefer, & Sommer, 2001), electromyography (EMG), electroencephalography (EEG) (Casson, Yates, Smith, Duncan, & Rodriguez-Villegas, 2010; Debener, Minow, Emkes, Gandras, & de Vos, 2012.), respiration (Wilhelm & Roth, 1996; Alpers, Wilhelm, & Roth, 2005; Grossman, Wilhelm, & Spoerle, 2004), temperature (van Marken Lichtenbelt et al., 2006), hormones (Kudielka, Broderick, & Kirschbaum, 2003; Kudielka, Gierens, Hellhammer, Wüst, & Schlotz, 2012; Schlotz, 2012), or glucose (Wagner, Tennen, & Wolpert, 2012). However, we do not capture these measures in this report (for further reviews see also Haynes & Yoshioka, 2007; Houtveen & de Geus, 2009; Wilhelm & Grossman, 2010; Wilhelm, Grossman, & Mueller, 2012).

3.1 The dawn of ambulatory physiological monitoring

Unlike momentary reports of current experience and behavior, which can be achieved with paper and pencil questionnaires, the assessment of physiological reactions requires sophisticated technical equipment. Such equipment was developed in the 1940s. In 1948 Fuller and Gordon introduced a relatively small device (12.2 x 2.2 x 2.2 cm) to radio-transmit pulse or respiration rates. Then, Holter and Gengerelli (1949, as cited in Kennedy, 2006) broadcasted the first ECG recorded during free exercise, with a huge and heavy vacuum tubes radio transmitter, which weighed 85 pounds. Also bulky was a portable radio transmitter for EEG or ECG monitoring developed by Parker, Breakell, and Christopherson (1953).

After the invention of the transistor, devices became more powerful and much smaller (Ko & Neuman, 1967). An improved ECG radio-transmitter used in a feasibility study with a myocard infarct patient during exercise in 1952 could already be put in a clothing pocket (MacInnis, 1954), and by the end of the 1950s, parallel radio transmission of ten channels was already possible with compact and lightweight devices (< 1 kg, Dunn & Beenken, 1959).

Although the inventors of biotelemetric systems immediately recognized their potential to investigate unrestrained human and animal behavior under the “physical and emotional conditions encountered in the stress and strain of daily living” (Holter, 1957, p. 913), the use of biotelemetric systems was limited to studies of aircraft and space pilots until the end of the 1950s.

3.2 Biotelemetry in space traveling

At the same time, physiological monitoring began to play an essential role in military and space research. Biotelemetric systems were developed to monitor aircraft pilots and to investigate the possibility of manned space flights (Barr & Voas, 1960; Beischer & Fregly, 1962). Already in the summer of 1948, U.S. scientists began to launch rockets with monkeys into high altitude. They continuously monitored and transmitted the monkeys’ HR and respiration to the control center to investigate the bodily effects of high acceleration, low gravity, and cosmic radiation during rocket flights. Although the monitoring system failed on the first flight, data was successfully transmitted during subsequent flights, which showed that the monkeys were alive until impact and that physiological reactions did not exceed their natural limits (Henry et al., 1952, as cited in Beischer & Fregly, 1962; Historical Division, Holloman Air Force Base, 1958).

A comparable research program began in 1949 in the former Soviet Union (Beischer & Fregly, 1962). In November 1957, Soviet scientists and engineers sent the first living being – a dog called Laika – into orbit (space program Sputnik 2). Laika’s blood pressure, ECG, respiration-rate, and motor activity was monitored and transmitted to earth (Sisakian, 1962, as citied in West, 2001). Further successful missions with dogs followed (see Antipov et al., 1963, for a detailed report). They showed that during launch HR of the dogs almost tripled and systolic blood pressure increased between 20 and 60 mmHg. After arrival in space, both decreased to the initial level, but HR-normalization took almost three times as long as during centrifuge testing on earth. In sum, during these flights no pathological changes were observed, and the data gathered showed that manned space flight is possible (Gazenko, Il'in, & Parfenov, 1974; Parfenov, 1975).

After the successful orbital flight of Laika, the U.S.A. intensified their research efforts with the goal of sending humans into space (Mills Link, 1965, Swenson, Grimwood, & Alexander, 1989). However, Soviet scientists and engineers accomplished this goal first. On

April 12, 1961, they launched cosmonaut Yuri Gagarin into the orbit (project Vostok 1). During his 1 hour 48 minute journey around the earth, he was televised, and his ECG and respiration were recorded and transmitted to earth. Gagarin's HR increased from 65 beats/minute four hours before launch to 108 beats/minute five minutes before launch, indicating emotional arousal due to the psychological stress associated with the impending space flight. It further rose to over 150 beats/minute after launch when he was exposed to vibration, noise, and increasing acceleration, but decreased to below 100 beats/minute after reaching orbit (Volynkin et al., 1962, as citied in West, 2001). Similar HR changes during launch have been observed in later astro- and cosmonauts. (Simonov, 1975, p. 558). Interestingly, HR increase measured five minutes before launch was much stronger in cosmonauts who traveled alone than in cosmonauts who traveled in company (84% vs. 34% increase of HR compared to the initial level; Simonov, 1975).

Ten months later in February 1962, John Glenn was the first American in orbit (project Mercury Atlas 6). During his journey ECG, respiration, and rectal temperature, was tele-monitored, and blood pressure was measured. However, the blood pressure recorder was not yet fully automatisized and Glenn had to inflate the cuff manually (Bayevskiy & Adey, 1975; Mills Link, 1965).

Meanwhile Soviet scientists further extended physiological monitoring, because cosmonaut Titov experienced motion sickness and illusory sensations during his 25 hours orbital flight in spaceship Vostok 2 (August, 1961) (Yuganov & Kopanev, 1975). Therefore, in addition to ECG, respiration, and skin resistance, EEG, and EOG were recorded during the three and four days flights of Vostok 3 and 4 (August, 1962) to evaluate cerebral changes and the performance of the vestibular system under prolonged conditions of weightlessness (Akulinichev et al., 1964). For an overview of physiological measures assessed during further Soviet and U.S. American space missions see Bayevskiy and Adey (1975).

In the history of behavior science probably it is during space missions that the best documented behavior observations have been made.. Physiology, behavior, communication, and task performance of astronauts and cosmonauts, in addition to environmental changes were continuously monitored (Mills Link, 1965). Based on data gathered during different missions, Simonov (1975) reported physiological reactions to emotion eliciting events. For example, when in March 1965 the cosmonaut Aleksei Leonov went on the first space walk ever made, his HR increased more than 60 beats/minute. West (2001) adds, that Leonov had severe problems reentering the space-ship and almost ran out of oxygen before he succeeded. During this 12 minute episode his HR reached 152 to 162 beats/minute and his respiration rate doubled. Another very particular event was Neil Armstrong's landing on the moon in July, 1969, during which Amstrong's HR rose more than 60 beats/minute to 150 beats/minute. HR increases in both men were probably due to a mix of excitement and stress they were experiencing at that particular moment (Simonov, 1975).

To summarize, extensive physiological and behavioral monitoring has been an essential part of space missions until today (e.g., Bayevskiy & Adey, 1975; Baevski et al., 2007; West, 2000), and space traveling has stimulated the further development of biotelemetry and physiological monitoring (Bayevskiy & Adey, 1975). Physiological and behavioral monitoring was necessary to supervise the physical wellbeing of early space travelers in their training and preparation and during their space missions. "Without the continuous monitoring of the physiological conditions of the astronaut, the margin of safety for his life would not be adequate to justify the risk involved." (Mayo-Wells, 1963, p. 512). After flight, environmental, biological, physiological, behavioral, and performance data were rigorously examined, to better understand the effects of the environmental changes during space traveling on the physiological and psychological functioning of astronauts and cosmonauts (Mills Link, 1965; ch.10).

3.3 Early ambulatory ECG-monitoring studies

To overcome some limitations of biotelemetric systems such as radio interference, short assessment duration, and restricted range of transmission, Holter (1961) and colleagues developed an ambulatory ECG-recorder (1 kg weight) with a storage capacity of 10 hours. After ten hours the magnetic tape on which data was stored had to be changed. In addition they offered a system for fast data screening of the extensive records (about 50,000 heartbeats in 10 hours) and automatized detection of sinus-arrhythmias (Holter, 1961; Gilson, Holter, & Glasscock, 1964). For the further stages in the development of ambulatory physiological recorders see de Geus and van Doornen, 1996; Jain, Martens, Mutz, Weiß, and Stephan (1996), Kennedy (2006), Stephan, Mutz, Feist, and Weiß, (2001), Wilhelm, Pfaltz, and Grossman, 2006, and for a more recent review Ebner-Priemer and Kubiak (2007).

Thus, at the beginning of the 1960s, different portable ECG-monitoring systems were available, and cardiologists began to monitor the ECGs of patients over longer time periods, during physical exercise, and their usual daily lives, to investigate arrhythmias, conduct disturbances, ischemia, and anginal pain (e.g., Bellet, Eliakim, Deliyiannis, & Lavan, 1962; Gilson, et al., 1964). Such studies showed that certain pathological changes in cardiac activity (e.g. transient arrhythmias, ischemic episodes) were not visible in a standard laboratory ECG but did occur during patients' daily activities (e.g., Cerkez, Steward, & Manning, 1965; Corday, Bazika, Lang, Pappelbaum, Gold, & Bernstein, 1965; Norland & Semler, 1964; Rothfeld, Bernstein, Crews, Parsonnet, & Zucker, 1965). In addition, case reports demonstrated that ambulatory ECG-monitoring enabled a better diagnosis of causes of syncope, and thus helped to avoid unnecessary implantations of pacemakers (Ira, Floyd, & Orgain, 1964).

Some researchers were interested in the physiological effects of particular activities performed under different environmental conditions. In a single case self-study Sanders and Martt (1966) investigated effects of high altitude on cardiac activity during sleep, and different levels of physical exercise. During all activities HR was lower at sea level than in in high altitude. In another pilot study Pollit, Almond, & Logue (1968) compared novice and experienced skiers. During rest, novice skiers who were not acclimatized to the altitude had higher HRs than experienced skiers, but maximal HRs were not different during skiing. Moreover, zoologists radio-monitored the ECGs of swimming and diving humans, mammals, and fish (Baldwin, 1965), or the ECGs, respiration rates, tidal air flows, and minute ventilations of flying pigeons (Hart & Roy, 1966)

Other researchers investigated physiological effects of real-life stressors. Concerned with car accidents caused by myocardial infarction, the German traffic physiologist Hoffmann (1962, 1965) used radio telemetry to monitor ECGs of 600 healthy persons and several patients with coronary heart diseases while they drove a test-car. In addition, Hoffmann measured blood pressure and documented traffic conditions. Just driving a car, even in low density rural traffic, increased HR in most drivers due to the physical and mental workload associated with driving. HR increases were stronger in city traffic, but strongest in critical situations (e.g., sudden stops, overtaking) in which also most pathologically relevant changes in the ECG occurred.

Similar studies followed in which the ECGs of patients and healthy controls were monitored while they drove their own cars in normal traffic (Bellet, Roman, Kostis, & Slater, 1968) or busy city-traffic (Taggart, Gibbons, & Somerville, 1969). HR increased during driving in patients and healthy subjects, but manifestations of myocardial ischemia were more frequent in patients. Taggart et al. also monitored 10 racing drivers and found their HRs to be much higher than those of the city drivers. Before the start, racing drivers had HRs of 150 to 180 beats/minute, which increased further to levels between 180 and 210 beats/minute by the time of the start, and remained at that level during the next 20 minutes.

To investigate physiological habituation, Fenz and Epstein (1967) compared skin conductance, heart- and respiration rate of novice and experienced parachutists during a series of events leading up to a jump (e.g. boarding, take off, reaching different altitudes, before jumping). In novice parachutists, physiological arousal increased steadily until they jumped, whereas experienced jumpers showed an initial increase followed by a slight decrease before jumping. For example, when parachutists arrived at the airport HR was slightly above 80 beats/minute in both groups. However, before jumping it was close to 110 beats/minute in experienced, but almost 150 beats/minute in novice parachutists. According to Fenz and Epstein, these results suggested that novice parachutists, in contrast to more experienced ones, had not developed effective inhibitory control mechanisms to master their fear reactions. In a later study Fenz (1973) showed that poorly performing parachutists had more difficulties.

In an early ambulatory study on work related stressors, Ira, Whalen, and Bogdonoff (1963) monitored physicians and medical students in situations perceived as stressful, like staff-conferences, ward-round presentations, or cardiac catheterizations. In these situations, they observed strong HR-increases that were not noticed by the participants. Many studies to assess the cardiac effects of work in different professions followed (for a brief overview see Fahrenberg & Wientjes, 2000; Payne & Rick, 1986; Zanstra & Johnston, 2011).

3.4 The need to control for physical activity

When HR of freely moving persons is monitored as in the study of Ira et al. (1963), it is difficult to interpret a HR-increase during a particular task or activity as an indicator of psychological stress, because such an increase can also be due to an increase in metabolic demands caused by physical activity (e.g., Houtveen & de Geus, 2009; Myrtek et al., 1996b; Wilhelm, Grossman, & Müller, 2012). Therefore, adequate measurement and control of metabolic demands became essential in later studies. Investigating the stress of surgeons during an operation, Becker, Ellis, Goldsmith, and Kaye (1983) measured oxygen consumption as an indicator of metabolic demands. In fact, HR increases during the operation could largely be explained by metabolic demands. Payne and Rick (1986) found HR of surgeons during an operation to be higher than HR of anesthetists (100.5 vs. 78.3 beats/minute), but they attributed this difference in HR to different metabolic demands. Surgeons' metabolic demands were higher, because they were standing and performing manual tasks under intense lightning, while anesthetists were physically less active and not exposed to higher temperature due to intense lightning.

To control metabolic demands in people's daily lives, body movements have been monitored and taken into account for the interpretation of physiological changes. In an early psychophysiological study over 24 hours, Roth, Tinklenberg, Doyle, Horvath, and Kopell (1976) recorded the ECG and movements of the arm and leg in addition to self-ratings of physical activity, and concurrent mood. They then descriptively compared HR between situations in which physical activity was similar. Taylor et al. (1982) proposed an off-line algorithm that categorized HR changes in conjunction with physical activity (measured with a motion sensor attached to the thigh) to identify automatically episodes of physical exercise, usual physical activity, or "anxiety" (elevated HR but low physical activity).

Some years later, Myrtek et al. (1988) developed an interactive ambulatory monitoring system to detect non-metabolic HR-increases (additional HR), which indicate emotional arousal or mental workload (Myrtek et al., 1996a, 1996b; Myrtek, 2004). The system monitored ECG and physical activity (assessed with accelerometers on the sternum and the thigh) over 23 hours. During the monitoring, an online algorithm compared HR and physical activity. An increase in HR was assumed to indicate emotional arousal when the HR at a given minute was substantially higher than the average HR during the preceding three minutes, but physical activity increased only slightly or not at all. When the system detected such a HR-increase it gave an acoustic signal. Participants then briefly recorded their current emotional state, activity, and setting. In addition, the system generated random signals. Thus, participants answered questions presented by the interactive recorder every 10 to 20 minutes, without knowing whether the questioning was triggered randomly or by their physiological arousal. Studying more than 1300 individuals (students, schoolchildren, workers, and patients) Myrtek and colleagues found for example, that although emotionally triggered HR-increases were frequent, participants did not usually recognize them, which indicates that the perception of physiological arousal during daily life is rather poor (Myrtek, 2004; Myrtek, Aschenbrenner, & Brügner, 2005).

3.5 Ambulatory psychophysiological monitoring of patients with mental disorders

In the 1980s, Roth, Taylor, and colleagues from the Stanford School of Medicine began to investigate anxiety disorders in patients' daily lives. Initially, they were interested in panic disorder, which is characterized by a sudden onset of intense fear and is therefore difficult to study under laboratory conditions. In a pioneer study, Taylor, Telch, and Havvik (1983) monitored HR and physical activity of ten panic patients over 24 hours. They reported eight attacks of which three were associated with increased HR that was not due to physical activity. Monitoring ECG for three days Margraf, Taylor, Ehlers, Roth, and Agras (1987) found that HR increased when panic was experienced during feared situations or in anticipation of such situations, but not during spontaneously occurring attacks. In sum, such studies revealed that in contrast to patients' self-reports, panic attacks usually occur with only moderate or even without physiological changes (Alpers, 2009). Moreover, they provided evidence against etiological hypotheses, which propose that panic episodes are due to cardiovascular pathology or peripheral hyperresponsiveness.

In later studies, ECG, skin conductance, respiration, and other measures were monitored during *in vivo* exposure of patients with driving or flight phobia. In contrast to healthy controls, patients reported more anxiety and higher physiological arousal while driving a car (Alpers, et al., 2005; Sartory, Roth, & Kopell, 1992) or flying by plane (Wilhelm & Roth, 1996, 1998). As expected, anxiety and physiological arousal decreased during a second exposition, indicating successful habituation. However, no habituation occurred in patients who took benzodiazepines during the first exposition, suggesting that anxiolytic treatment hinders effects of exposure (Wilhelm & Roth, 1997). Meanwhile, ambulatory psychophysiological monitoring has also been conducted with other diagnostic groups (e.g., depressed and borderline patients; see Ebner-Priemer & Trull, 2009; Santangelo, Bohus, & Ebner-Priemer (in press).

3.6 Ambulatory assessment of blood pressure

3.6.1 Devices to record blood pressure during daily life

Already 1941, Gilson, Goldberg, and Slocum reported on an automatic non-invasive device to consecutively record blood pressure every 30 seconds. Improved recorders were then developed and implemented in aircrafts and space-vehicles to measure blood pressure in pilots and astronauts (Bayevsky & Adey, 1975; Ware & Kahn, 1963; Zuidema, Edelberg, & Salzman, 1956).

Portable devices to measure blood pressure during daily life are available since the 1960s. Hinman, Engel, and Bickford (1962) designed a portable semiautomatic blood-pressure recorder (5.5 pounds) for ambulatory clinical research and some years later, fully automated portable devices were available (Schneider, 1968; Schneider & Costiloe, 1975). The market for such devices increased rapidly, and about 20 years later O'Brien and O'Malley (1990) identified already 13 manufacturers who produced at least 18 different ambulatory systems to measure non-invasive blood pressure.

In 1969, Bevan, Honour, & Stott introduced a portable apparatus to measure intra-arterial blood pressure continuously for 12 hours with a microcatheder inserted into a brachial artery. This system was further improved to store systolic and diastolic beat-to-beat pressure assessed over 24 hours, together with the ECG and electronically marked events on a standard compact cassette (Littler, Honour, Sleight, & Stott, 1972). Although, intra-arterial blood pressure measurement is the most precise method to assess blood pressure continuously (Littler & Komsuoglu, 1989), it is invasive and therefore its use is limited and not suited for psychological research.

Prototypes to measure blood pressure non-invasively, beat by beat, with finger cuffs equipped with an infrared photoplethysmograph were developed in the early 1980s by Wesseling, and colleagues (see Imholz et al., 1993, Imholz, Wieling, Montfrans, &

Wesseling, 1998; Parati et al., 2003). At the beginning of 1990s a portable device for continuous 24-hour finger arterial pressure recording—the portapres—was available, soon followed by an improved and smaller device (portapres 2) (Imholz et al., 1993; Schmidt & Jain, 1996). Different validation studies showed however considerable disagreement between finger arterial blood pressure monitoring and intra-arterial monitoring or other methods of blood pressure measurement (Fahrenberg & Myrtek, 2005; Imholz et al., 1993; 1998). For more recent developments see Parati et al. (2003), for example.

Different organizations have published standards for the validation of blood pressure measurement devices. According to the Association for the Advancement of Medical Instrumentation (AAIM) (1987, as cited in Stanton & O'Brien, 1993) a test device should not differ by more than 5 mmHg, with a standard deviation of less than 8 mmHg from the mercury measurement. The British Hypertension Society (O'Brien et al., 1993) evaluates devices according to the percentage of measurements differing from the mercury standard by 5, 10, or 15 mmHg.

Mancia and Parati (1993) criticized the protocol of the British Hypertension Society. They argued that it would not be sufficient to compare blood pressure assessed with an ambulatory device to measures obtained with a sphygmomanometer at the same time, because such measures are taken during controlled rest and are therefore not representative for measures obtained during daily life. Several studies (see Mancia & Parati, 1993; Omboni, Parati, Groppelli, Ulian, & Mancia, 1997) showed that differences between simultaneously assessed intra-arterial measures and noninvasive ambulatory blood pressure measures are rather small during rest, but could be large in other situations. During daily life, sliding of the cuff, movements of the arm, contraction of the muscles, and environmental factors could impair noninvasive ambulatory measures. Therefore, the validation of noninvasive ambulatory blood pressure devices should also comprise a comparison with simultaneously assessed intra-arterial blood pressure assessed during daily life. Although this problem was briefly mentioned in the recommendations of the European Society of Hypertension (O'Brien, Waeber, Parati, Staessen, & Myers, 2001), standards for the validation of ambulatory blood pressure measurement devices have not been substantially changed (O'Brien et al., 2010). For current online reviews of devices according to the standards of the AAIM, the British Society of Hypertension, and the International Protocol of the European

Society of Hypertension see http://www.dableducational.org/).

3.6.2 Ambulatory blood pressure assessment

In ambulatory blood pressure studies and in clinical practice, participants and patients usually keep a diary to protocol their current activity and other information of interest. As for the interpretation of HR-changes it is crucial to control physical activity and posture when ambulatory blood pressure changes are interpreted (Fahrenberg, 1996b). Many studies investigated blood pressure changes in particular situations, or during different activities like sleeping (e.g. Littler, 1979), car driving (e.g. Hoffmann, 1965; Littler, Honour, & Sleight, 1973), or during the performance of specific work related tasks (e.g., Fahrenberg & Wientjes, 2000; Rau & Richter, 1996). Also blood-pressure during particular daily life behaviors like smoking (Cellina, Honour, & Littler, 1975), micturition and defecation (Littler, Honour, & Sleight, 1974a), or coitus (Littler, Honour, & Sleight, 1974b) has been assessed. In addition, effects of psychological stress, social support, or perceived control on ambulatory blood pressure have been studied (for an overview see Fahrenberg, 1996b; Rau, 2001; Steptoe, 2001; Zanstra & Johnston, 2011).

3.6.3 Intra-individual variability and discrepancies between blood pressure assessed in the doctor's office and in daily life

Early ambulatory blood pressure studies were concerned with changes of blood pressure over time and with setting and context effects. Already 1930, Brown (as citied in Ayman & Goldshine, 1940) found substantial between day variations in the blood pressure of a hypertensive patient who measured his own blood pressure daily over three years.

Using the first generation of semiautomatic portable recorders, Kain, Hinman, and Sokolow (1964) let hypertensive patients, who followed their daily routines, measure their blood pressure every 30 minutes over a 12 hour period at two or three consecutive days. Ambulatory measures varied substantially within individuals. Although average ambulatory measures were highly correlated with measures taken in the clinic, blood pressure was estimated to be lower when it was measured ambulatory. Sokolow, Werdegar, Kain, and Hinman (1966) replicated these findings. In addition, they found that average ambulatory blood pressure correlated higher with the severity of hypertensive complications than the average blood pressure assessed in the clinic, and concluded that clinical measures represent patients' usual net pressure load poorer than ambulatory measures.

Doubts regarding the diagnosis of hypertension based on casual measures taken in the clinic or in the physician's office were already raised before by Ayman and Goldshine (1940). They instructed 34 hypertensive patients to measure their blood pressure at home twice a day for several weeks and compared these measures with those obtained when the patients visited a clinic or a physicist. They found home measures to be lower in most patients, but there were also huge individual differences. For about a third of the patients the average systolic blood pressure measured in the doctor's office was not more than 10 mmHg above the blood pressure measured at home. For a second third blood pressure measured in the officce was 10 to 30 mmHg higher than at home, and even more than 30 mmHg for the last third. Ayman and Goldshine (1940) attributed the higher values measured in the office to tension and excitement patients may experience, when they visit a doctor. Such excitement should be especially strong in patients with "a tense psychomotor makeup" (p. 471). In addition, Ayman and Goldshine (1941) showed that daily home readings allow a better control of treatment effects than clinical measures.

Ayman and Goldshine's findings have been replicated many times. Yarows, Julius, and Pickering (2000) summarized studies conducted in the eighties and nineties. On average systolic and diastolic pressure was 8.1 and 5.6 mmHg lower at home than in the office. However, discrepancies between home measures and ambulatory measures taken during daytime were below 2 mmHg and clinically not relevant. In a recent meta-analysis of randomized control studies Cappuccio, Kerry, Forbes, & Donald (2004) reported smaller, but still significant discrepancies between blood pressure measures taken at home and those taken in the clinic or office.

Moreover, Ayman and Goldshine's (1940) explanation, that the difference between office and home measures is due to tension and excitement many patients might experience when they visit a doctor, was closer examined and confirmed in a field-experimental by Mancia et al. (1983). They monitored intra-arterial blood pressure of hospitalized inpatients over 24 hours, and found a strong increase when a doctor arrived at the patients' bed to measure blood pressure (which was the experimental condition). The patients' arousal was not related to the blood pressure assessment performed by the doctor, but to his appearance at the bedside. Mancia et al. (1983, p. 697) assumed that the doctor's appearance causes an "alarm reaction" in many patients, which will often lead to a false positive diagnosis of hypertension, if the diagnosis is only based on blood pressure measurements taken in the office or clinic. This kind of misdiagnosis has been termed *white coat hypertension* (Pickering et al., 1988). The prevalence of white coat hypertension was estimated to be 10 percent (O'Brien et al., 2003).

Also the opposite misclassification, termed *reverse white-coat hypertension, or masked hypertension* has been found in 9 to 23 percent of persons participating in different epidemiological studies (Pickering, Davidson, Gerin, & Schwartz, 2002): People are diagnosed as normotensive when they are measured in the office, but are hypertensive by ambulatory blood pressure measurement. Thus, if the diagnosis is only based on measures taken in the office, hypertension will probably fail to be detected in a substantial part of the patients.

In sum, studies on ambulatory and home measured blood pressure have led to a change in the standards for diagnosing hypertension and since more than a decade, medical institutions and societies recommend the use of ambulatory blood pressure monitoring for diagnosis and intervention control (e.g., Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, 1997, 2004; O'Brien et al., 2003, 2005). Since 2002, 24 hours ambulatory blood pressure measurement is reimbursed in the U. S. for patients with suspected white coat hypertension (Department of Health & Human Services (DHHS), Centers for Medicare & Medicaid Services, 2001).

4. Monitoring Body Movements and Physical Activity in Daily Life

Many methods and devices have been developed for assessing body movements in people's daily lives (for an overview see Bussmann & Ebner-Priemer, 2012; Bussmann, Ebner-Priemer, & Fahrenberg, 2009; Tryon, 1991). From the data collected with these methods, important features of behavior in everyday life can be inferred. In the following sections, we briefly review the origin and development of research based on step counters (pedometers) and other devices to assess movements of the whole body or of particular parts of the body.

4.1 Counting steps and estimating distances walked

The first blueprint for a mechanical *pedometer* to count pendulum movements of the thigh was devised by Leonardo da Vinci (1452-1519) (Hoff & Geddes, 1962). One hundred years later, Anselmus Boeti de Boodt (1550-1632), physician and curator of gems of Rudolph II in Prague, described a pedometer combined with a compass to record on paper the distance and direction walked (Hoff & Geddes, 1962).[3] Until the 20th century, geographers and explorers used pedometers to measure distances walked, thereby improving the precision of route descriptions and maps (e.g., Burton & Speke, 1858; Hicks, 1946; Wilkinson, 1843)

In human research, mechanical pedometers were probably the first instruments that allowed automatic recording of people's daily life activities. Already 1882, Hodges used a pedometer to measure distances nurses and other health professional walked during a workday in a hospital. Assuming that a step corresponds to a distance of 27 inches, he found that they walked between 7 and 22 miles a day, which was two to four times the distance of women who spent the day at home. He concluded that such an amount of daily walking, in addition to prolonged standing might cause various health problems. Thompson (1913) and Gray (1935) observed working conditions of nurses in more detail, and based on pedometer

[3] The invention of a pedometer has been mistakenly attributed to Thomas Jefferson, the 3ed president of the U.S.A. ("Jefferson, Man of Science", 1943). In fact, Thomas Jefferson (1830a) saw a pedometer integrated in a pocket watch, in Paris. He briefly described the device in a letter to James Madison (Feb, 8, 1786). Later, he bought such a device and sent it to Madison with instructions for use (Jefferson, 1830b, letters to James Madison, June 20, 1977; May 3, 1788).

measures they came to similar conclusions as Hodges and criticized that nurses have to walk too much, due to long wards and unfavorable and inefficient work conditions.

Pedometers played a role in a variety of early 20th century research. For example, physicians used pedometers in case studies to demonstrate physical improvement of patients after a new pharmacological treatment (e.g., Fordyce, 1914). Sociologist Curtis (1914) suggested measuring children's daily activity (by pedometer) to investigate how environmental conditions, in particular availability of attractive playgrounds, affect their activity levels. From his own observations and single pedometer measures, he hypothesized that schoolchildren living in environments without adequate provision for play would move two to three miles less per day. Billings (1934) measured the activity of six female psychiatric patients throughout their menstrual cycles. He found a postmenstrual peak in women's activity, which continuously declined until the next period. About forty years later, Morris and Udry (1969) reported that women taking contraceptive pills were less active, as measured by the pedometer, than women who did not take contraceptive pills.

New insights have also been gained by self-studies. One remarkable self-study was done by a Swiss doctor who counted his steps by using a pedometer during one year. He found that he had walked 9,760,900 steps in total ("A Doctor's Footsteps", 1894). Wearing a pedometer during winter while performing mostly sedentary activities (writing), physiologist Benedict (1910) recognized that he still had been walking about seven miles per day, much more than he had expected. Based on a similar experience, when measuring the distances walked during his work in the hospital, German physicist Lauter (1926) concluded that the extent of physical activity cannot be accurately assessed by mere self-report. This conclusion was confirmed in later studies (Bussmann & Ebner-Priemer, 2012).

Investigating the etiology of obesity, Lauter (1926) claimed that overweight is the result of increased caloric intake in conjunction with lower energy expenditure due to reduced physical activity. Although Lauter did not assess physical activity in obese patients, his reasoning was later confirmed in a pedometer study by Larsen (1949; as cited in Chirico & Stunkard, 1960), who showed that hospitalized obese patients walked less than hospitalized non-obese patients. Chirico and Stunkard (1960) replicated the results in two studies with obese and. non obese women and men wearing individually calibrated pedometers for one or two weeks, respectively. In addition, Stunkard (1958) took daily pedometer measures of eight obese psychotherapy patients over several months. He reported examples of short- and long- term associations between daily physical activity and patients' mood (assessed in therapeutic sessions), showing that bad or depressed mood was associated with a decrease in activity.

Already more than hundred years ago, Kisch (1903, as cited in Joslin, 1903) recommended the use of pedometers in the treatment of obese patients. And a recent meta-analysis of 26 studies (Bravata et al., 2007) shows that pedometer use results in an average increase of one mile in daily walking and leads to positive health effects such as a decrease of systolic blood pressure. However, weight reduction did not seem to be associated with an increase in walking due to pedometer use.

4.2 Assessing body-movements during activity, rest, and sleep

To investigate rest- and activity-patterns in different species, including humans, the Viennese biologist Szymanski (1914, 1918) designed different *actographs*. Based on the principle of a balance, his actographs recorded movements of an animal in a cage, or movements of a human in a bed or on a seat. In a serious of experiments, Szymanski (1918) demonstrated that activity patterns follow a 24-hour cycle even in the absence of external stimuli like light or temperature, providing evidence for an endogenous biological clock. In contrast to human adults, who usually have an activity period during the day and a rest period during the night, Szymanski (1922) observed a polyphasic cycle in newborn infants, with five to six activity periods relatively equally distributed over 24 hours. Simplified actographs, which could be attached to a bed, were developed by sleep researchers. With such a *hypnometer*, Karger (1925) recorded body movements to investigate normal and disturbed sleep behavior in children. He observed large variations in children's movements during sleep, and found that the extent of activity was not an indicator of sleep depth.

A few years later, the EEG was introduced in sleep research, and polysomnography (recording of EEG, EOG, EMG, and ECG) assessed in a sleep laboratory has become the diagnostic gold standard. Nevertheless, monitoring of physical activity still plays an important role in sleep assessment. Early validation studies conducted in the 1970s demonstrated high agreement between arm movements measured by electronic wrist-worn movement sensors (*actigraphs,* see next paragraph) and stages of sleep and wakefulness determined by EEG (Sadeh, Hauri, Kripke, & Lavie, 1995). Since the 1980s, algorithms for automatic distinction between sleep and wakefulness from actigraph data have been developed. Actigraphs enable an easy assessment of sleep behavior in the natural environment over long time periods, with almost no burden for participants. As a result, they have been used in hundreds of sleep studies (Ancoli-Israel et al., 2003; Sadeh, 2011; Sadeh et al., 1995).

4.3 Assessing movements of body parts

Schulman and Reisman (1959, as cited in Johnson, 1971) modified an automatically winding wristwatch to record acceleration due to movement of the body part to which it was attached (usually a wrist or ankle). Schulman and colleagues used this modified watch—called an *actometer*—to investigate physical activity in children with hyperactivity and retardation and to explore effects of sedative drugs (see Johnson, 1971; Tryon, 1991). MacCoby, Dowley, and Hagen (1965) investigated whether there is a relationship between intelligence and activity, measured with an actometer. They found no correlation between activity in nursery school children's free play and their IQ. However, during tasks requiring inhibition of movements, children with higher IQs moved less, indicating that ability to inhibit activity becomes crucial for cognitive performance.

In the 1970s, technology progressed rapidly. *Actigraphs* (watch-size electronic tilt counters, with piezoelectric sensors) and *accelerometers* (acceleration measures that are sensitive to frequency and intensity of movements) were developed (Montoye & Taylor, 1984; Tryon, 1991). Size, precision, and storage capacity of the devices have since then been steadily improved, and the number of studies conducted with such devices has rapidly increased in sleep and other areas of clinical- and health research.

Changes in physical activity and movement patterns are diagnostic criteria for many mental disorders. Therefore, motor behavior in psychiatric patients' daily lives has been investigated extensively. Research conducted in the 1970s and 1980s revealed that locomotor activity is elevated in patients with Attention Deficit Hyperactivity Disorder (ADHD), mania, agitated depression, and Alzheimer's disease, but reduced in patients with seasonal affective disorder and bipolar depression. Moreover, changes in circadian activity rhythms have been found in patients with depression and Alzheimer's disease (Teicher, 1995). Studies on hyperactive children showed that not periods of extreme activity were typical for hyperactivity but the absence of quiescent periods and the inability to inhibit activity during tasks requiring such inhibition (Teicher, 1995). Moreover, actigraphy has been used to study effects of psychoactive drugs on nocturnal and diurnal behavior in patients and healthy volunteers (Stanley, 2003; Teicher, 1995).

Actigraphs and accelerometers have been used to estimate energy expenditure, which is the most crucial control variable in psychophysiological monitoring studies and also relevant in research on health behavior. Reviewing different methods to assess physical activity in epidemiological research, Laporte, Montoye, and Caspersen (1985) mention high accuracy, low reactivity and low burden for participating subjects as advantages of electronic movement monitors. However, they argued that large population studies would remain unlikely until prices of the devices decrease. Meanwhile, such population studies have now been conducted. For example, Riddoch and colleagues, (2007) monitored physical activity of 5595 British children for seven consecutive days with accelerometers worn at the hip. Alarmingly, they found that only 5.1% of the boys and 0.4% of the girls achieved the recommended level of daily physical activity.

4.4 Assessing coordination of movements and identifying different activities

More than 130 years ago, the French physician and inventor Étienne Jules Marey (1878) described devices and procedures to assess synchronization of movements in humans and animals during gait. Marey also invented an apparatus to measure the frequency of birds' wing beats during flight. He connected the bird under study via wires with a recording device, which however constrained its flight to a short distance of 14 meters. About eighty years later, the progress in radio telemetry allowed the continuation of Marey's studies under natural conditions. Lord, Bellrose, and Cochran (1962) monitored wing movements and respiration of a wild duck during free flight with a 38g radio transmitter, attached behind the duck's wings. They observed that the duck performed a wing beat during exhalation and another between respirations, and that respiration frequency during flight was seven times higher than during rest.

Monitoring of complex movement patters in humans under daily life conditions became possible in the 1990s with the development of multichannel accelerometry. Signals of various sensors attached to different body parts are recorded simultaneously. With a configuration of three piezoresistive sensors, one attached to the sternum and two at the thighs, Foerster (2001) and colleagues could automatically discriminate the current body position (standing, sitting, lying) and motor activity (e.g., walking, running, riding a bike). Multichannel accelerometry now plays an important role in rehabilitation medicine (Bussmann, 1998; Bussmann et al., 2009; Bussmann & Ebner- Priemer, 2012).

5 Tracking the Geographical Location of Animals and Humans

5.1 Radio telemetry to track spatial movement of wild animals

Zoologists were probably the behavior scientists who first recognized the potential of biotelemetry and applied many technologies developed in space engineering and space medicine for their research (Adams, 1965; Slagle, 1965; see Benson, 2010 for a detailed historical report, and Kenward, 2001 for a recent overview of wild life tracking methods). In early applications of telemetry, the location of freely moving wild animals like bears (Craighead, & Craighead, 1965), deers (Tester & Heezen, 1965), rabbits, skunks, raccoons (Cochran & Lord, 1963), or rats (Sanderson & Sanderson, 1964) was tracked with VHF radio transmitters, in order to study animals' spatial movement and obtain information about their home range.

Compared to the standard method to obtain such information - setting live traps and count in which traps animals marked for identification were found - the advantages of telemetry are obvious: Data are continuously gathered from an individual (thus information is available at which time an animal stays at which place), the animal's natural behavior is not interrupted, and it is more cost efficient than life trapping (Adams, 1965; Sanderson, 1966). However, in a review of methods to study animal movements Sanderson (1966) also mentioned disadvantages: In the 1960s radio tracking was time consuming, the equipment was expensive, and it was unknown what effects the attachment of a transmitter had on the behavior and movement of an animal.

Current telemetry systems used in animal research have become very small and powerful (weight of transmitter 1.8 g) and allow the tracking of various individuals at the same time with signals send in intervals below one minute (e.g., Briner, Airoldi, Dellsperger, Eggimann, & Nentwig, 2003). With such systems, spatial movement and activity patterns of small animals, like mice, and interactions between them can now be studied.

5.2 Satellite based tracking systems

Since the early 1970s satellite communication systems allow the tracking of widely roaming or migrating animals (and humans). In 1978 the French location and data collection system *Argos,* which was connected to weather satellites *Nimbus* and later to *Tiros N*) began to operate and to provide services for location tracking (Kenward, 2001; Rodgers, Rempel, & Abraham, 1996).

The first tags for satellite tracking— called *platform transmitter terminals* (PTT)— were rather heavy (5-11 kg) and therefore only suitable for large animals. PTTs soon became smaller (Kenward, 2001). However, the systems were not very precise: Average errors of position estimates were between 0.5 and 1.5 km (Rodgers et al. 1996). In a study to evaluate the accuracy of 30g-PTTs operating with Argos, which were used to document migration roots of peregrine falcons, Britten, Kennedy, & Ambrose (1999) found that in 68 percent of the records positional accuracy was far above 1 km. They therefore recommended this system for the study of migrations on broad spatial scales, but not when positional accuracy smaller than 35 km is needed, as in the study of animals habitat use.

In 1978 the first generation of satellites for the NAVSTAR *Global Positioning System* (GPS) which was created and realized for military purposes by the U.S. Department of Defense, were launched, and was opened for civil and commercial use in the 1980s. In 1995, the second generation of GPS satellites were fully operational, but local precision for nonmilitary use was limited to 100 meters. The U. S. government eliminated this “selective availability” in Mai 2000. Since then usual handheld GPS systems achieve a positional accuracy of 10 to 20 meters (Pellerin, 2006). However, even before Mai 2000, errors could be compensated by adding another location sensor at a known fixed position, which enabled the correction of the position signals received by the target sensor. This *differential correction* reduces positioning errors to 5 meters. The method is also called *Differential Global Positioning System* (DGPS). Differential GPS with surveying-grade systems even achieve a positional accuracy in the range of centimeters (Johnson & Barton, 2004). However, such systems are expensive and require specialized staff. Therefore, they are usually used for geodetic surveys by professional land surveyors, where such a level of precision is required. Meanwhile different U.S. state departments provide manuals for the use and selection of GPS systems (Vermont Center for Geographic Information, 2005; Wisconsin Department of Natural Resources, 2001).

Current GPS-based systems designed for animal tracking are capable of collecting location data over long periods of time, with high spatial- and temporal resolution (e.g. every 15 min, over one year; Clark et al., 2006). However, under field conditions positional precision of GPS data can be impaired, because terrain and vegetation interfere with the satellite signals necessary to acquire the location, which then produces spatial inaccuracy and missing data, and may in turn lead to wrong conclusions (Dussault, Courtois, Ouellet, & Huot, 1999; D'Eon, 2003; Frair et al., 2004; Johnson & Barton, 2004).

Never the less, from position data it can be inferred how far animals move at which time. This already allows rough estimates of animals' activity patterns. For example, in a GPS study, Merrill and Mech (2003) observed that wolves showed more intense movement during the night than during the day, with movement peaks during crepuscule. However, when a male wolf went on an extraterritorial foray for four weeks his main movement pattern shifted from nocturnal to diurnal, which allowed him to use visual cues for navigation. They further tracked a breeding female wolf. The first six weeks after whelping the wolf stood close to the pups in the den, then distances and times away increased. When the pups were ten months old their mother already left them unattended for 17 days. During this period pups remained most of the time at the rendezvous site and other pack members probably supported them with food.

The combination of GPS with additional motion or physiological sensors allows an even more precise assessment of patterns of activity and inactivity in its ecological context (e.g., Coulombe, Massé, & Côté, 2006, see also Cagnacci, Boitani, Powell, & Boyce, 2010).

5.3 Location tracking for surveillance of offenders

Although it would had been of great value for ecological psychologists studying behavioral settings (e.g., Barker, 1968), location tracking was hardly ever used in human research during the 1960s and 1970s.

However, in reviews of devices for behavior modification Schwitzgebel (1968, 1970) suggested the use of location tracking for discharged psychiatric patients, geriatric or retarded individuals, and juvenile delinquents. In fact, Robert Schwitzgebel and his brother Ralph and colleagues (Schwitzgebel, Schwitzgebel, Pahnke, & Hurd, 1964) developed and patented a prototype radio-frequency transmitter/receivers system for location tracking of juvenile offenders. A later system was even capable of two way communication (e.g. monitoring the location and sending tactile signals back to the monitored person) (Schwitzgebel & Bird, 1970). Schwitzgebel promoted location tracking for rehabilitation of criminal recidivists as a humanitarian alternative to incarceration which would allow the reduction of criminal offenses and the facilitation of therapy. However, both systems were too expensive and "Schwitzgebel's efforts to promote EM [electronic monitoring][4] fell upon the shores of economic and technical impracticality" (Mainprize, 1996, see also Gable & Gable, 2005, p. 21).

More than a decade later, a second attempt to develop an electronic monitoring system for the surveillance of offenders was more successful. Jack Love, judge in Albuquerque, New Mexico, was inspired by a Spiderman comic strip and initiated 1983 the development of an electronic system to monitor five offenders (Courtright, 2002). The National Institute of Justice (NIJ) evaluated the system and found that it functions successfully. The NIJ therefore recommend electronic monitoring as a cost-effective and legally tenable alternative to incarceration (Ford & Schmidt, 1985; as cited in Klein-Saffran, 1993).

Since then, different technical solutions have been developed. Early systems were based on continuous signaling telecommunication. A small transmitter, attached to the offender's ankle or wrist, sent signals to a receiver unit, which was connected via telephone to a central computer. Another technique was based on a programmed contact system. Offenders wore a decoder device, which received control calls at random times. They then had to call back, and an automatic system checked their location and identity (Schmidt, 1998). Meanwhile, electronic monitoring systems use GPS technology, which allows continuous location tracking of offenders, confined to home arrest or curfew. Probation officers are automatically informed when offenders are not staying at the location where they are supposed to stay at predefined time (e.g. home or work) or when they are entering an unauthorized area (e.g., violent husbands that are not allowed to approach their wives' home) (Courtright, 2002).

After its invention electronic monitoring of offenders soon became popular. In 1987 already more than 900 offenders participated in electronic monitoring programs which had

---

[4] In the U.S. the term electronic monitoring is used whereas in Great Britain the term electronic tagging is common to label the surveillance of a target person with an electronic device, that is attached to his or her body. In addition, the term electronic braclets is used in both countries.

begun in 21 U.S. states. During the next years the number of persons electronically monitored greatly increased. At the beginning of the new millennium about 20 percent of the community based supervisions in the U.S. probably involved electronic monitoring. In Sweden, already 1998, 25 percent of the 15,000 prisoners were put on electronic monitoring (see Gable & Gable, 2005).

In England and Wales electronic monitoring was introduced through the Criminal Justice Act 1991, and the Crime and Disorder Act 1998 extended location tagging to monitor offenders on Home Detention Curfew (offenders who are released from imprisonment). Since 1998 three private companies are in charge of providing the equipment and conducting the supervision of offenders who are either on Home Detention Curfew, or sentenced to a curfew order up to six months for less severe crimes (e.g., shop lifting, drug offences, thefts) . The number of offenders, who were electronically monitored, increased from 9,000 in 1999-2000 to 53,000 in 2004-2005 (National Audit Office, 2006).

The fast increase of electronic monitoring was due to a rapid development of the technology, which has made the surveillance of offenders more efficient and reliable. In the U.S., overcrowding of prisons due to mandatory minimal prison terms (e.g., for low level drug offence) became a problem, which could also be reduced by electronic monitoring.
In addition, electronic monitoring has obvious social and psychological benefits. The Home Office (as cited in the National Audit Office, 2006), for example, identified the following benefits of Home Detention Curfew, supervised by electronic monitoring: It allows offenders to stay with their families, and to work, or look for work. It helps to provide structure in their lives, and it facilitates the transition from life in prison to life in the community.
Another important reason for the increasing application of electronic monitoring is that it significantly reduces expenses. In England and Wales, electronically monitoring offenders on Home Detention Curfew for 90 days cost 1300£, whereas 90 days of custody cost 6500£. Thus, electronic monitoring of home detention is much cheaper than imprisonment (National Audit Office, 2006).

As already mentioned, in the U.S.A. and Great Britain the surveillance of offenders is delegated to private companies. Gable and Gable (2005) estimated that in 2005 about 20 companies were involved in this business. Transaction volumes are already quite large and will probably further increase. In 2004-05, for example, the British Home Office paid the three authorized British companies £102.3 million for the electronic monitoring contracts, which was in average £1,943 per curfew (National Audit Office, 2006).

Meanwhile some companies have extended applications and offer continuous electronic monitoring of alcohol consumption (e.g., http://www.gpsmonitoring.com) or provide safety services for private customers, such as GPS tracking of elderly, mentally retarded people, children, and even students. In addition, GPS tracking is offered for enterprises to control mobile or lone employees, vehicles, construction equipment, assets, or moving goods (e.g., http://www.gps-tracker.com/personal-gps-tracker).

5.4 Using GPS to investigate physical activity and behavior environment interactions in humans

Although location tracking has a long history in animal research it has almost not been used in human research before 2000 (for a review of human research with a focus on physical activity see Maddison & Ni Mhurchu, 2009). The first GPS study on humans, we are aware of, was conducted by Schutz and Chambaz (1997). They investigated, whether GPS could be used to assess velocity in walking, running, and cycling and found an almost perfect correlation between velocity estimates based on GPS-measures and chronometry. Other studies confirmed that GPS can be used to measure the velocity and distances of movements walked, ran, or cycled (see Maddison & Ni Mhurchu, 2009).

Therefore, GPS has been increasingly used to assess the performance of athletes in different disciplines like cross country skiing, orienteering, or Golf (see Maddison & Ni Mhurchu, 2009). It has also been applied to track football- or soccer-players position and velocity during games (Pino, Martinez-Santos, Moreno, & Padilla, 2007; Wisbey, Montgomery, Pyne, & Rattray, 2009). However, a recent study by Gray, Jenkins, Andrews, Taaffe, & Glover (2010) demonstrated limitations of GPS technology to assess sport performance. They showed that 1 Hz GPS recorders accurately measured the distance of linear movements travelled at intensities ranging from walking to sprinting, but tend to underestimate the intensity of non-linear movements on circular or curved paths.

GPS was also used to assess the current location, traveling patterns and movement behavior of children, adolescents, and adults. For example, Holton (2003) reported the use of wearable GPS sensors, to investigate the amount of time children living in agricultural rural regions spent in pesticide-affected areas. Wiehe, Hoch, Liu, Carroll, Wilson, & Fortenberry (2008) used GPS enabled cell phones to track 15 female adolescent's location during one week. The adolescent distance away from home was greatest during weekend evenings.

Combining GPS and activity monitoring with actigraphs, Jones, Coombes, Griffin, & van Sluijs (2009) investigated which environments children between 9 and 10 years use for bouts of moderate to vigorous physical activity. They found that children, who were more active, spent more time outside. Sixty three per cent of the time with moderate to vigorous activity was spent close to the children's home. Especially urban children used gardens and street environments commonly for being active. "The results highlight the importance of the provision of urban gardens and greenspaces, and the maintenance of safe street environments as places for children to be active" (Jones et al., 2009, p.1). A recent GPS–activity monitoring study by Wheeler, Cooper, Page, & Russell (2010) supports this conclusion. They assessed the current location and physical activity of 1053 children between 10 and 11 years. Children spent less than 15% of the time after school outdoors. However, 30% of the activity volume and 35% of moderate to vigorous activity occured outdoors. Although, children performed most outdoor activity in areas not categorized as greenspace, activity was more intense in greenspace areas.

In a study on car driving behavior Porter and Whitton (2002) used GPS and video recording to investigate young (20 to 29 years), middle (30 to 64 years), and old participants (above 64 years), who drove their own car on a 26 km parcour. While GPS data was used to monitor the position, acceleration, and velocity, additional video recordings provided detailed information about the current traffic context. As no observer was present participants maintained their natural driving behavior. Young participants drove faster, had shorter acceleration and deceleration times and distances, and produced more infractions of traffic rules, mainly due to speeding.

Dill (2009) investigated, how infrastructure (traffic density, bicycle lanes) is related to bicycle use for everyday traveling. Hundred and sixty six inhabitants of Portland, Oregon, who regularly ride bicycles carried a personal digital assistant with GPS function for one week. Participants reported the destination (e.g., shopping, work) and the weather conditions before they went on a bike ride. The GPS unit sampled satellite signals every three seconds, from which the route and traveling speed could be calculated. Results showed that sixty percent of the participants rode more than two and a half hours per week, and that most riding was for utilitarian purposes, and not for exercise. This indicates that healthy levels of physical activity can already be achieved by using a bike for everyday travel. Results further showed that participants avoided roads with high traffic but at the same time tried to minimize trip distances. Dill (2009) concluded that everyday bicycling among adults could be encouraged by local politicians and city planners through providing a network of well-connected neighborhood streets and bike lanes. This study shows how GPS technology can be used to base infrastructure development on a detailed analysis on a of user behavior.

6 Summary and Conclusion

In this report, we have highlighted important steps in the history of four major approaches to assess experiences and behavior in people's daily lives: Diaries and self-record methods, psychophysiological monitoring, monitoring of body movements, and tracking of the geographical location. In reviewing this history, we were surprised to recognize that the roots of research conducted in daily life reached back to the 19th century. Only a few years after Wilhelm Wundt founded the first laboratory for experimental psychology (1879, at the University of Leipzig), William Thierry Preyer (1882/1889) outlined systematic rules to enhance the trustworthiness of observation records of infants' spontaneous behavior; R. M. Hodges (1882) used pedometers to obtain objective measures of distances walked at the workplace; and Hugo Münsterberg (1892) proposed three dimensions of affect experienced in daily life, based on a long-term self-record study, to which he added psychological tests performed under field conditions.

These pioneers of research in daily life conducted case studies. However, since the 1920s, impressive group studies have been carried out in which participants recorded their daily or even momentary experiences and events on structured scales. Even at this early stage, the motivation for researchers to gather data in a person's daily life was the same as it is today: Avoiding distortions due to memory biases and enhancing the ecological generalizability of results.

By tracing these methods back to the 19th century, we add to other reviews that located their beginnings more recently in the 20th century. For example, reviewing the origin of self-record-methods, Wheeler and Reis (1991) acknowledged time budget and work sampling studies, mainly conducted after World War II, as precursors of daily self-record-studies. More recent reviews with a historical perspective date the oldest self-record studies back to the 1920s (e.g., Stone et al., 2007). Wheeler and Reis (1991) also noted that due to behaviorism, there was essentially a moratorium on the study of inner experience between the 1920s and 1960s. However, we found several studies published during that period, so there were at least exceptions regarding such a moratorium.

Fahrenberg (2001) associated the origin of ambulatory assessment (characterized by the use of mobile electronic or mechanical devices to measure experiences, physiological reactions, or behavior in people's daily lives) with Holter's invention of portable ECG-monitoring recorders in the 1950s. Today, we would see Hodges' (1882) use of pedometers to measure distances walked at the workplace as the beginning of ambulatory assessment. Historical reviews in the future will probably find even older studies as the number of psychological and medical journals that allow electronic screening of their earlier publications increases.

Although researchers have long been aware of the advantages of an objective assessment of physiological reactions and everyday movement behavior, such research has mostly been conducted in a medical or biological context. Despite the great potential of both approaches for psychological research, their applications in psychology have been rather the exception (e.g., Fahrenberg & Myrtek, 1996; 2001; Tryon, 1991). However, as recent reviews show, the situation is changing and more psychologists are beginning to examine objective features of behavior and physiology in addition to subjective experiences in people's daily lives (e.g., Alpers, 2009; Bussmann & Ebner-Priemer, 2012; Bussmann et al., 2009; Ebner-Priemer & Trull, 2009; Haynes & Yoshioka, 2007; Houtveen & de Geus, 2009; Kaplan & Stone, 2013; Kubiak & Stone, 2012; Stadler, Snyder, Horn, Shrout, & Bolger, 2012;.Trull & Ebner-Priemer, 2009; 2013; Wilhelm & Grossman, 2010; Wilhelm, Grossman, & Mueller, 2012). This development has been fostered through scientific networks that have recently merged into the Society for Ambulatory Assessment (http://www.ambulatory-assessment.org/).

In order to fully appreciate the contributions of early researchers, it is important to recognize that they had to overcome many obstacles that made their studies much more cumbersome and laborious than today. Especially in diary studies, researchers had to manage and analyze the multitude of information they gathered, without the help of computers. Results were usually presented descriptively. However, some pioneers already calculated statistical tests (e.g., Flügel, 1925, Kambouropoulou, 1926; Thomson, 1930). Since the 1980s, powerful statistical methods, such as multilevel models (Goldstein, 1995; Snijders & Bosker, 1999; Raudenbush & Bryk, 2002) have been designed that are able to cope with the peculiarities of data gathered in daily life (hierarchical structure, unequal number of observations, missing data, and autocorrelation). Multilevel models have been increasingly applied since the 1990s and are now considered the standard method for analyzing such data (e.g., Bolger et al., 2003; Bolger & Laurenceau, 2013; Nezlek, 2008; Reis & Gable, 2000;

Singer & Willet, 2003; for an overview on recent developments see Mehl & Conner, 2012, part III; Bolger & Laurenceau, 2013; Crayen, Eid, Lischetzke, Courvoisier, & Vermunt, 2012; Rosmalen, Wenting, Roest, de Jonge, & Bos, 2012). The availability of handheld computers (or mobile phones) for data gathering and the improvement of statistical methods have contributed to the rapidly increasing number of diary studies during the last two decades (e.g., Tennen, Affleck, & Armeli, 2005).

Conducting research in this field has become more sophisticated but in certain aspects also easier than ever before. Researchers today have a great variety of recording technologies, computer programs, and statistical tools available to investigate many different facets of people's experience and behavior—advances of which the pioneers in the field of research in daily life could only dream.

References

"A doctor's footsteps" (1894). *Journal of the American Medical Association, 23,* 287.

Adams, L. (1965). Progress in ecological biotelemetry. *BioScience, 15*, 83-86.

Allen, G. I., Breslow, A.,Weissman, A., & Nisselson, H. (1954). Interviewing versus diary keeping in eliciting information in a morbidity survey. *American Journal of Public Health, 44,* 919-927.

Akulinichev, I. T., Bayevskiy, R. M., Belay, V. Ye., Vasil'yev, P. V., Gazenko, O. G., … Yazdovskiy, V. I. (1964). Results of physiological investigations on the spaceships Vostok 3 and Vostok 4. English Translation of a Technical Report (NASA, Accession ID: 65N13627). Retrieved from http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19650004026_1965004026.pdf

Allport, G. W. (1942). *The use of personal documents in psychological science*. New York, NY: Social Science Research Council.

Alpers, G. W. (2009). Ambulatory assessment in panic disorder and specific phobia. *Psychological Assessment, 21,* 476–485.

Alpers, G. W., Wilhelm, F. H., & Roth, W. T. (2005). Psychophysiological assessment during exposure in driving phobic patients. *Journal of Abnormal Psychology, 114*, 126–139.

Ancoli-Israel, S., Cole, R., Alessi, C., Chambers, M., Moorcroft, W., & Pollak, C. P. (2003). The role of actigraphy in the study of sleep and circadian rhythms. *Sleep, 26*, 342-392.

Antipov, V. V., Bayevskiy, R. M., Gazenko, O. G., Genin, A. M., Gyurdzhian, A. A., … Yazdovskiy, V. I. (1963). Some results of medical and biological investigations in the second and third satellites. English Translation of a Technical Report (NASA, Accession ID: 64N11687). Retrieved from. http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19640001778_1964001778.pd

Arrington, R. E. (1943). Time sampling in studies of social behavior: A critical review of techniques and results with research suggestions. *Psychological Bulletin, 40*, 81-124.

Ayman, D., & Goldshine, A. D. (1940). Blood pressure determinations by patients with essential hypertension, I: The difference between clinic and home readings before treatment. *American Journal of the Medical Sciences, 200*, 465-474.

Ayman, D., & Goldshine, A. D. (1941). Blood pressure determinations by patients with essential hypertension, II: The difference between home and clinic readings during and after treatment. *American Journal of the Medical Sciences, 201*, 157-161.

Baevsky, R. M., Baranov, V. M., Funtova, I. I., Diedrich, A., Pashenko, A. V., . . . Tank, J. (2007). Autonomic cardiovascular and respiratory control during prolonged spaceflights aboard the International Space Station. *Journal of Applied Physiology, 103*, 156–161.

Baldwin, H. A. (1965). Marine biotelemetry. *BioScience, 15,* 95-97.

Barker, R. G. (1968). *Ecological psychology*. Palo Alto, CA: Stanford University Press.

Barker, R. G., & Wright, H. F. (1951) One boy's day: *A specimen record of behavior*. New York, NY: Harper & Bros.

Barker, R. G., & Wright, H. F. (1955). *Midwest and its children*: New York, NY: Harper.

Barr, N. L., & Voas, R. B. (1960). Telemetering physiologic responses during experimental flights. *American Journal of Cardiology, 6*, 54-61.

Barrett, L. F., & Barrett, D. J. (2001). An introduction to computerized experience sampling in psychology. *Social Science Computer Review, 19*, 175–185.

Barta, W. D., Tennen, H., & Litt, M. D. (2012). Measurement reactivity in diary research. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 108-123). New York, NY: Guilford.

Baumann, U., Thiele, C., Laireiter, A. R., & Krebs, A. (1996). Computer-assisted interaction diary on social networks, social support, and interpersonal strain. In J. Fahrenberg & M. Myrtek (Eds.), Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies (pp. 69–83). Seattle, WA: Hogrefe & Huber.

Bayer, C. A. (1972). Self-monitoring and mild aversion treatment of trichotillomania. *Journal of Behavior Therapy and Experimental Psychiatry, 3,* 139-141.

Bayevskiy, R. M., & Adey, W. R. (1975). Methods of investigation in space biology and medicine: Transmission of biomedical data. In M. Calvin, & O. G. Gazenko (Eds.), *Foundations of space biology and medicine (Vol. 2, Book 2). Ecological and physiological bases of space biology and medicine* (pp. 668- 706). Washington, DC: Scientific and Technical Information Office, NASA.

Beck, A. T., Rush, A. J., Shaw, B. F., & Emery, G. (1979). *Cognitive therapy of depression: A treatment manual.* New York, NY: Guilford Press.

Becker, W.G. E., Ellis, H., Goldsmith, R., & Kaye, A. M. (1983). Heart rate of surgeons in theatre. *Ergonomics, 26,* 803-807.

Beischer, D. E., & Fregly, A. R. (1962). *Animals and man in space: A chronology and annotated bibliography through the year 1960.* ONR Rep. ACR-64 (USNSAM Monograph 5). Washington, DC: Office of Naval Research, Department of the Navy.

Bellet, S., Eliakim, M., Deliyiannis, S., & Lavan, D. (1962). Radioelectrocardiography during exercise in patients with angina pectoris. *Circulation, 25*, 5-14.

Bellet, S., Roman, L., Kostis, J., & Slater, A. (1968). Continuous electrocardiographic monitoring during automobile driving: Studies in normal subjects and patients with coronary disease. *American Journal of Cardiology, 22*, 856-862.

Benedict, F. G. (1910). The influence of mental and muscular work on nutritive processes. *Proceedings of the American Philosophical Society, 49*, 145-163.

Benson, E. (2010). *Wired wilderness: Technologies of tracking and the making of modern wildlife.* Baltimore, MD: Johns Hopkins University Press.

Bernard, H. R., Killworth, P., Kronenfeld, D., & Sailer, L. (1984). The problem of Informant accuracy: The validity of retrospective data. *Annual Review of Anthropology, 13*, 495-517.

Bernard, H. R., Killworth, P., & Sailer, L. (1982). Informant accuracy in social network data V: An experimental attempt to predict actual communication from recall data. *Social Science Research, 11*, 30-66.

Bevan, A. T., Honour, A. J., & Stott, F. H. (1969). Direct arterial pressure recording in unrestricted man. *Clinical Science, 36,* 329-344.

Bevans, G. E. (1913). *How workingmen spend their spare time.* Unpublished dissertation. New York, NY: Columbia University, New York.

Billings, E. G. (1934). The occurrence of cyclic variations in motor activity in relation to the menstrual cycle in the human female. [Abstract]. *Bulletin of the Johns Hopkins Hospital, 54*, 440-454.

Bolger, N., Davis, A., & Rafaeli, E. (2003). Diary methods: Capturing life as it is lived. *Annual Review of Psychology, 54,* 579–616.

Bolger, N., & Laurenceau, J. P. (2013). *Intensive longitudinal methods: An introduction to diary and experience*. New York, NY: Guilford.

Bolger, N., Shrout, P. E., Green, A. S., Rafaeli, E., & Reis, H. T. (2006). Paper or plastic revisited: Let's keep them both—reply to Broderick and Stone (2006); Tennen, Affleck, Coyne, Larsen, and DeLongis (2006); and Takarangi, Garry, and Loftus (2006). *Psychological Methods, 11,* 123–125.

Boucsein, W. (2012). Electrodermal activity (2nd ed.). New York, NY: Springer.

Boucsein, W., Schaefer, F., & Sommer, T. (2001). Electrodermal long-term monitoring in everyday live. In J. Fahrenberg, & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psycho-logical and psychophysiological methods in monitoring and field studies* (pp. . 549-560). Seattle, WA: Hogrefe & Huber.

Brandstätter, H. (2007). The time sampling diary (TSD) of emotional experience in everyday life situations. In J. A. Coan & J. J. B. Allen (Eds.), Handbook of Emotion Elicitation and Assessment (pp. 318-331). New York: Oxford University Press.

Bravata, D. M., Smith-Spangler, C., Sundaram, V., Gienger, A. L., Lin, N., . . . Sirard, J. R. (2007). Using pedometers to increase physical activity and improve health: A systematic review. *Journal of the American Medical Association, 298,* 2296-2304.

Briner, T., Airoldi, J.-P., Dellsperger, F., Eggimann, S., & Nentwig, W. (2003). A new system for automatic radiotracking of small mammals. *Journal of Mammalogy, 84*, 571-578.

Britten, M. W., Kennedy, P. L., & Ambrose, S. (1999). Performance and accuracy evaluation of small satellite transmitters. *The Journal of Wildlife Management, 63*, 1349-1358.

Brunswik, E. (1943). Organismic achievement and environmental probability. *Psychological Review, 50*, 255-272.

Brunswik, E. (1947). *Systematic and representative design of psychological experiments.* Berkeley, CA: University of California Press.

Brunswik, E. (1955). Representative design and probabilistic theory in a functional psychology. *Psychological Review, 62,* 193-217.

Bühler, C. (1922). *Das Seelenleben des Jugendlichen. Versuch einer Analyse und Theorie der psychischen Pubertät* [The psyche of the juvenile: Attempt of an analysis and theory of psychological puperty]. Jena, Germany: G. Fischer.

Bühler, K. (1921). *Die geistige Entwicklung des Kindes* [The mental development of the child] (2nd ed.). Jena, Germany: G. Fischer.

Burnett, K. E., Taylor, C. B., & Agras, W. S. (1985). Ambulatory computer-assisted therapy for obesity: A new frontier for behavior therapy. *Journal of Consulting and Clinical Psychology, 53*, 698-703.

Burns, T. (1954). The directions of activity and communication in a departmental executive group: a quantitative study in a British engineering factory with a self-recording technique. *Human Relations, 7,* 73-97.

Burton, R. F., & Speke, J. H. (1858). A coasting voyage from Mombasa to the Pangani river, Visit to sultan Kimwere, and progress of the expedition into the interior. *Journal of the Royal Geographical Society of London, 28*, 188-226.

Buse, L., & Pawlik, K. (1996). Ambulatory behavioral assessment and in-field performance testing. In J. Fahrenberg & M. Myrtek (Eds.), Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies (pp. 29–50). Seattle,WA: Hogrefe & Huber.

Buse, L., & Pawlik, K. (2001). Computer-assisted ambulatory performance tests in everyday situations: Construction, evaluation, and psychometric properties of a test battery measuring mental activation. In J. Fahrenberg, & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 3-23). Seattle, WA: Hogrefe & Huber.

Bussmann, J. B. J. (1998). Ambulatory monitoring of mobility-related activities in rehabilitation medicine. Delft, The Netherlands: Eburon.

Bussmann, J. B. J., & Ebner-Priemer, U. W. (2012). Ambulatory activity monitoring: Assessing activity, posture, and motion patterns in daily life. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 235-250). New York, NY: Guilford.

Bussmann, J. B. J., Ebner-Priemer, U. W., & Fahrenberg, J. (2009). Ambulatory activity monitoring: Progress in measurement of activity, posture, and specific motion patterns in daily life. *European Psychologist, 14*, 142–152.

Cagnacci, F., Boitani, L., Powell, R. A., & Boyce, M. S. (2010). Animal ecology meets GPS-based radiotelemetry: A perfect storm of opportunities and challenges. *Philosopical Transactions of the Royal Society B, 365*, 2157-2162. doi:10.1098/rstb.2010.0107

Cappuccio, F. P., Kerry, S. M., Forbes, L., & Donald, A. (2004). Blood pressure control by home monitoring: Meta-analysis of randomised trials. *British Medical Journal* doi:10.1136/bmj.38121.684410.AE

Carter, B. L., Day, S. X., Cinciripini, P. M., & Wetter, D. W. (2007). Momentary health interventions: Where are we and where are we going? In A. A. Stone, S. Shiffman, A. A. Atienza, & L. Nebeling (Eds.), *The science of real-time data capture. Self reports in health research* (pp. 289–307). New York, NY: Oxford University Press.

Casson, A. J., Yates, D. C., Smith, S. J. M., Duncan, J. S., & Rodriguez-Villegas, E. (2010). Wearable Electroencephalography: What is it, why is it needed, and What does it entail? *IEEE Engineering in Medicine and Biology Magazine, 29(*3), 44-56.

Cellina, G. U. Honour, A. J., & Littler, W. A. (1975). Direct arterial pressure, heart rate, and electrocardiogram during cigarette smoking in unrestricted patients. *American Heart Journal, 89*, 18-25.

Cerkez, M. D., Steward, G. C., & Manning, G. W. (1965). Telemetric electrocardiography. *Canadian Medical Association Journal, 93,* 1187-1199.

Chirico, A.-M., & Stunkard, A. J. (1960). Physical activity and human obesity. *The New England Journal of Medicine, 263(19),* 935-940.

Clark, P. E., Johnson, D. E., Kniep, M. A., Jermann, P., Huttash, B., Wood, A., … Titus, K. (2006). An advanced, low-cost, GPS-based animal tracking system. *Rangeland Ecology & Management, 59*, 334-340.

Cochran, W. W., & Lord, R. D. (1963). A radio-tracking system for wild animals. *The Journal of Wildlife Management, 27*, 9-24.

Conner, T. S., Barrett, L. F. (2012). Trends in ambulatory self-report: The role of momentary experience in psychosomatic medicine. P*sychosomatic Medicine, 74*, 327-337.

Conner, T. S., & Lehman, B. J. (2012). Getting started: Launching a study in daily life. In M. R. Mehl & T. S. Conner (Eds.). *Handbook of research methods for studying daily life* (pp. 89-107). New York, NY: Guilford.

Corday, E., Bazika, V., Lang, T.-W., Pappelbaum, S., Gold, H., & Bernstein, H. (1965). Detection of phantom arrhythmias and evanescent ECG abnormalities: Use of prolonged direct electrocardiocording. *Journal of the American Medical Association, 193,* 4I7-421.

Coulombe, M.-L., Massé, A., & Côté, S. D. (2006). Quantification and accuracy of activity data measured with VHF and GPS telemetry. *Wildlife Society Bulletin, 34*, 81-92.

Courtright, K. E. (2002). Electronic Monitoring. In D. Levinson (Ed.), *Encyclopedia of crime and punishment* (Vol. 2) (pp. 110-113). Thousand Oaks, CA: Sage.

Craighead, F. C., & Craighead, J. J. (1965). Tracking grizzly bears: *BioScience, 15*, 88-92.

Crayen, C., Eid, M., Lischetzke, T., Courvoisier, D. S., & Vermunt, J. K. (2012). Exploring dynamics in mood regulation-Mixture latent Markov modeling of ambulatory assessment data. *Psychosomatic Medicine, 74*, 366-376.

Csikszentmihalyi, M., & Hunter, J. (2003). Happiness in everyday life: The uses of experience sampling. *Journal of Happiness Studies, 4*, 185–199.

Csikszentmihalyi, M., Larson, R. W., & Prescott, S. (1977). The ecology of adolescent activities and experiences. *Journal of Youth and Adolescence, 6*, 281-294.

Curtis, H. S. (1914). The playground survey. *American Journal of Sociology, 19*, 792-812.

Darwin, C. (1877). A biographical sketch of an infant. *Mind, 2*, 285-294.

Debener, S., Minow, F., Emkes, R., Gandras, K., & de Vos, M. (2012). How about taking a low-cost, small, and wireless EEG for a walk? *Psychophysiology, 49*, 1449-1453.

Debrot, A., Cook, W. L., Perrez, M., & Horn, A. (2012). Deeds matter: Daily enacted responsiveness and intimacy in couples' daily lives. *Journal of Family Psychology, 26*, 617-627.

D'Eon, G. D. (2003). Effects of a stationary GPS fix-rate bias on habitat-selection analyses. *The Journal of Wildlife Management, 67*, 858-863.

deVries, M. W. (Ed.). (1992). *The experience of psychopathology Investigating mental disorders in their natural settings.* Cambridge, MA: Cambridge University Press.

Department of Health & Human Services (DHHS), Centers for Medicare & Medicaid Services (CMS) (2001). Medicare Coverage Issues Manual, Transmittal, 149. Retrieved from http://www.cms.gov/transmittals/downloads/R149CIM.pdf

Diener, E., & Larsen R. J. (1984). Temporal stability and cross-situational consistency of affective, behavioral, and cognitive responses. *Journal of Personality and Social Psychology, 47,* 871-883.

Dill, J. (2009). Bicycling for transportation and health: The role of infrastructure. *Journal of Public Health Policy, 30*, S95–S110.

Downes, J., & Collins, S. D. (1940). A study of illness among families in the eastern health district of Baltimore. *The Milbank Memorial Fund Quarterly, 18*(1), 5-26.

Dunn, F. L., & Beenken, H. G. (1959). Short distance radio telemetering of physiological information. *Journal of the American Medical Association, 169*, 1618-1621.

Dussault, C., Courtois, R., Ouellet, J.-P., Huot, J. (1999). Evaluation of GPS telemetry collar performance for habitat studies in the boreal forest. *Wildlife Society Bulletin, 27*, 965-972.

Ebner-Priemer, U. W., & Kubiak, T. (2007). Psychological and psychophysiological ambulatory monitoring: A review of hardware and software solutions. *European Journal of Psychological Assessment, 23*, 214-226.

Ebner-Priemer, U. W., & Trull, T. J. (2009). Ecological momentary assessment of mood disorders and mood dysregulation. *Psychological Assessment, 21*, 463–475.

Fahrenberg, J. (1996a). Ambulatory Assessment. Issues and perspectives. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 3-20). Seattle, WA: Hogrefe & Huber.

Fahrenberg, J. (1996b). Concurrent assessment of blood pressure, heart rate, physical activity, and emotional state in natural settings. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 165-187). Seattle, WA: Hogrefe & Huber.

Fahrenberg, J. (2001). Origins and developments of ambulatory monitoring and assessment. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 587-614). Seattle, WA: Hogrefe & Huber.

Fahrenberg, J., Hüttner, P., & Leonhart, R. (2001)._MONITOR: Acquisition of psychological data by a hand-held PC. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 93–112). Seattle, WA: Hogrefe & Huber.

Fahrenberg, J., & Myrtek, M. (Eds.). (1996). *Ambulatory Assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies*. Seattle, WA: Hogrefe & Huber.

Fahrenberg, J., & Myrtek, M. (Eds.). (2001). *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies.* Seattle, WA: Hogrefe & Huber.

Fahrenberg, J., & Myrtek, M. (2005). *Psychophysiologie in Labor, Klinik und Alltag. 40 Jahre Projektarbeit der Freiburger Forschungsgruppe Psychophysiologie* [Psychophysiology in laboratory, clinic, and everyday life. 40 years research programs of the Freiburg research group for psychophysiology]. Frankfurt, a. M., Germany: Peter Lang.

Fahrenberg, J., Myrtek, M., Pawlik, K., & Perrez, M. (2007)._Ambulatory assessment – monitoring behavior in daily life settings. *European Journal of Psychological Assessment, 23*, 206-213.

Fahrenberg, J., & Wientjes, C. J. E. (2000). Recording methods in applied environments. In R. W. Backs & W. Boucsein (Eds.), *Engineering psychophysiology: Issues and applications* (pp. 111-136). Mahwah, NJ: Lawrence Erlbaum.

Feldman Barrett, L., & Barrett, D. J. (2001). An introduction to experience sampling in psychology. *Social Science Computer Review, 19*, 175- 185.

Fenz, W. D., & Epstein, S. (1967).Gradients of physiological arousal in parachutists as a function of an approaching jump. *Psychosomatic Medicine, 29*, 33-51.

Fleeson, W., & Noftle, E. (2012). Personality Research. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 525-538). New York, NY: Guilford.

Flügel, J. C. (1925). A quantitative study of feeling and emotion in everyday life. *British Journal of Psychology. General Section, 15*, 318-355.

Foerster, F. (2001). Assessment of posture, motion, and hand tremor by calibrated accelerometry. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 233-256). Seattle, WA: Hogrefe & Huber.

Fordyce, J. A. (1914). The treatment of syphilis of the nervous system. *Journal of the American Medical Association, 63,* 552-558.

Fox, J. F. (1934). Leisure-time social background in a suburban community. *Journal of Educational Sociology, 7,* 493-503.

Frair, J. L., Nielsen, S. E., Merrill, E. H., Lele, S. R., Boyce, M. S., Munro, R. H. M., . . . Beyer, H. L. (2004). Removing GPS collar bias in habitat selection studies. *Journal of Applied Ecology, 41*, 201-212.

Fuller, J. L., & Gordon, T. M. (1948). The radio inductograph: A device for recording physiological activity in unrestrained animals. *Science, 108*, 287-288.

Gable, R. K., & Gable, R. S. (2005). Electronic monitoring: Positive intervention strategies. *Federal Probation, 69* (1), 21-25. Retrieved from: http://www.uscourts.gov/uscourts/FederalCourts/PPS/Fedprob/2005-06/intervention.html

Gazenko, O. G., Il'in, Ye. A., & Parfenov, G. P. (1974). Biologicheskiye Issledovaniya v Kosmose (Nekotoryye Itogn i Perspektivy). *Izvestiya Akademii Nauk SSSR. Seriya Biologicheskaya, 4*, 461-475. [Biological research in space (some conclusions and prospects), NASA Technical Translation, TT-F15, 961. Washington, DC: NASA].

Geus, E.J.C. de & Doornen, L.J.P. van (1996). Ambulatory assessment of parasympathetic/sympathetic balance by impedance cardiography. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory Assessment. Computer assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 141-164). Seattle, WA: Hogrefe & Huber.

Gilson, J. S., Holter, N. J., & Glasscock, W. R. (1964). Clinical observations using the electrocardiocorder-AVSEP continuous electrocardiographic system-tentative standards and typical patterns. *American Journal of Cardiology, 14*, 204-217.

Gilson, W. E., Goldberg, H., & Slocum, H. C. (1941). An automatic device for periodically determining and recording both systolic and diastolic blood pressure in man. *Science, 94,* 194.

Goldstein, H. (1995). Multilevel Statistical Models. (2nd ed.). London, U.K.: Edward Arnold. Since 1999 in electronic form. Retrieved from: http://www.bristol.ac.uk/cmm/team/hg/multbook1995.pdf

Gorin, A. A., & Stone, A. A. (2001). Recall biases and cognitive errors in retrospective self-reports: A call for momentary assessments. In A. Baum, T. Revenson, & J. Singer (Eds.), *Handbook of Health Psychology* (pp. 405–413). Mahwah, NJ: Erlbaum.

Gray, A. J., Jenkins, D., Andrews, M. H., Taaffe, D. R., & Glover, M. L.(2010). Validity and reliability of GPS for measuring distance travelled in field-based team sports. *Journal of Sports Sciences, 28* (12), 1319-1325.

Gray, C. E. (1935). Health, hours, and assignments. *The American Journal of Nursing, 35*, 529-537.

Green, A. S., Rafaeli, E., Bolger, N., Shrout, P. E., & Reis, H. T. (2006). Paper or plastic? Data equivalence in paper and electronic diaries. *Psychological Methods, 11*, 87–105.

Hammond, K. R. (1998). *Ecological validity: Then and now.* Unpublished manuscript Retrieved from http://brunswik.org/notes/essay2.htm.

Hank, P., & Schwenkmezger, P. (1996). Computer-assisted versus paper-and-pencil self-monitoring: An analysis of experiential and psychometric equivalence. In J. Fahrenberg & M. Myrtek, (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 86–99). Seattle, WA: Hogrefe & Huber.

Hart, J. S., & Roy, O. Z. (1966). Respiratory and cardiac responses to flight in pigeons. *Physiological Zoology, 39,* 291-306.

Harvey, A., St. Croix, A., & Reage, D. (2003). *The tale of two communities: Time use survey results from GPI Atlantic's Community Survey*. Retrieved from http://www.gpiatlantic.org/pdf/communitygpi/vol2appendix03.pdf

Haynes, S. N., & Yoshioka, D. T. (2007). Clinical assessment applications of ambulatory biosensors. *Psychological Assessment, 19*, 44-57.

Hedges, S. M., Jandorf, L., & Stone, A. A. (1985). Meaning of daily mood assessments. *Journal of Personality and Social Psychology, 48*, 428–434.

Hektner, J. M. (2012). Developmental Psychology. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 585-600). New York, NY: Guilford.

Hektner, J. M., Schmidt, J. A., & Csikszentmihalyi, M. (2007). *Experience sampling method: Measuring the quality of everyday life*. Thousand Oaks: Sage Publications.

Hicks, P. H. (1946). The portal peaks of Ruwenzori. *The Geographical Journal, 108*, 210-220.

Hinman, A. T., Engel, B. T., & Bickford, A. F. (1962). Portable blood pressure recorder: Accuracy and preliminary use in evaluating intradaily variations in pressure. *American Heart Journal, 63*, 663-668.

Hinrichs, J. R. (1964). Communication activity of industrial research personnel. *Personnel Psychology, 17*, 193-204.

Historical Division, Holloman Air Force Base (1958). *History of research in space biology and biodynamics at the Air Force Missile Development Center, Holloman Air Force Base, New Mexico, 1946-1958.* Retrieved from http://history.nasa.gov/afspbio/contents.htm

Hodges, R. M. (1882). Painless synovial effusions. *Boston Medical and Surgical Journal, 107*, 534-536.

Hoff, H. E., & Geddes, L. A. (1962). The beginnings of graphic recording. *Isis, 53*, 287-324.

Hoffmann, H. (1962). Experimentelle Kreislaufuntersuchungen bei gesunden und vegetativ-labilen Kraftfahrzeugfahrern [Experimental studies of the circular flow in healthy and vegetative labile vehicle drivers*]. Hefte zur Unfallheilkunde, 71*, 127-139.

Hoffmann, H. (1965). Medizinisch-Psychologische Untersuchungen zum Fahren im Verkehrsfluß [Psycho-medical studies of driving in the traffic stream]. *Zeitschrift für Verkehrssicherheit, 11,* 145-156.

Holter, N. J. (1957). Radioelectrocardiography: New technique for cardiovascular studies. *Annals of the New York Academy of Science, 65*, 913-923.

Holter, N. J. (1961). New method for heart studies. *Science, 134*, 1214-1120.

Holton, W. C. (2003). Positioning through play clothes: Wearable GPS devices track exposures. *Environmental Health Perspectives, 111*, A42.

Hoppmann, C. A., & Riediger, M. (2009). Ambulatory assessment in lifespan psychology: An overview of current status and new trends. *European Psychologist, 14*, 98–108.

Houtveen, J. H., & Geus, E. J. C. de (2009). Noninvasive psychophysiological ambulatory recordings: Study design and data analysis strategies. *European Psychologist, 14*, 132–141.

Hufford, M. R., & Shields, A. L. (2002). Electronic diaries: Applications and what works in the field. *Applied Clinical Trials, 11,* 38–43.

Hunscher, H. A.,Vincent, E. L., & Macy, I. G. (1930). Psychophysiological studies: I. The technique of securing quantitative and coördinated psychological and physiological data on lactating women in their usual home environment. *Child Development, 1,* 15-28.

Hurlburt, R. T. (1979). Random sampling of cognitions and behaviour. *Journal of Research in Personality, 13*, 103-111.

Hurlburt, R. T., & Heavey, C. L. (2004). To beep or not to beep: Obtaining accurate reports about awareness. *Journal of Consciousness Studies*, *11,* 113-128.

Hurlburt, R. T., & Sipprelle, C. N. (1978), Random sampling of cognitions in alleviating anxiety attacks. *Cognitive Therapy and Research, 2*, 165-169.

Hyland, M. E., Kenyon, C. A., Allen, R., & Howarth, P. (1993). Diary keeping in asthma: Comparison of written and electronic methods. *British Medical Journal, 306,* 487-489.

Imholz, B. P. M., Langewouters, G. J., van Montfrans, G. A., Parati, G., van Goudoever, J., ... Mancia, G. (1993). Feasability of ambulatory, continuous 24-hour finger arterial pressure recording. *Hypertension, 21*, 65-73.

Imholz, B. P. M., Wieling, W., van Montfrans, G. A., Wesseling, K. H. (1998). Fifteen years experience with finger arterial pressure monitoring: Assessment of the technology*. Cardiovascular Research, 38*, 605–616.

Intille, S. S. (2007). Technological innovations enabling automatic, context-sensitive ecological momentary assessment. In A. A. Stone, S. Shiffman, A. A. Atienza, & L. Nebeling (Eds.). *The science of real-time data capture* (pp. 308-337). New York, NY: Oxford University Press.

Ira, G. H., Floyd, W. L., & Orgain, E. S. (1964). Syncope with complete heart block: Differentiation of real and simulated Adams-Stokes seizures by radiotelemetry. *Journal of the American Medical Association, 188*, 707-710.

Ira, G. H., Whalen, R. E., & Bogdonoff, M. D. (1963). Heart rate changes in physicians during daily 'stressful' tasks. *Journal of Psychosomatic Research, 7,* 147-150.

Jain, A., Martens, W. L. J., Mutz, G., Weiß, R. K., & Stephan, E. (1996). Towards a comprehensive technology for recording and analysis of multiple physiological parameters within their behavioral and environmental context. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 215-235). Seattle, WA: Hogrefe & Huber.

"Jefferson, Man of Science" (1943). *The Science News-Letter, 43*(16), 250.

Jefferson, T. R. (Ed.). (1830a). Memoir, correspondence, and miscellanies, from the papers of Thomas Jefferson (Vol. 1, 2ed ed.). Boston, MA: Gray & Bowen. Retrieved from http://www.gutenberg.org/ebooks/16781

Jefferson, T. R. (Ed.). (1830b). Memoir, correspondence, and miscellanies, from the papers of Thomas Jefferson (Vol. 2, 2ed ed.). Boston, MA: Gray & Bowen. Retrieved from http://www.gutenberg.org/ebooks/16782

Johnson, C. F. (1971). Hyperactivity and the machine: The actometer. *Child Development, 42*, 2105-2110.

Johnson, C. E., & Barton, C. C. (2004). Where in the world are my field plots? Using GPS effectively in environmental field studies. *Frontiers in Ecology and the Environment, 2*, 475-482.

Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (1997). *The sixth report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*. National Institutes of Health (Publication No. 98-4080). Retrieved from http://www.nhlbi.nih.gov/guidelines/archives/jnc6/jnc6_archive.pdf

Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (2004). *The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*. U.S. Department of Health and Human Services (NIH Publication No. 04-5230). Retrieved from http://www.nhlbi.nih.gov/guidelines/hypertension/jnc7full.pdf

Jones, A. P., Coombes, E. G., Griffin, S. J., & van Sluijs, E. M. F. (2009)._Environmental supportiveness for physical activity in English schoolchildren: A study using Global Positioning Systems. *International Journal of Behavioral Nutrition and Physical Activity, 6*: 42. doi:10.1186/1479-5868-6-42

Joslin, E. P. (1903). Progress in therapeutics. *Boston Medical and Surgical Journal, 148*, 444-446.

Kain, H. K., Hinman, A. T., & Sokolow, M. (1964)._Arterial blood pressure measurements with a portable recorder in hypertensive patients: I. Variability and correlation with “casual” pressures. *Circulation, 30*, 882-892.

Kambouropoulou, P. (1926). Individual differences in the sense of humor. *American Journal of Psychology, 37,* 268-278.

Käppler, C., & Rieder, S. (2001). Does the retrospective effect hold as a stable phenomenon? First results from a transcultural self monitoring study of mood and cognitive states in Brazil and Germany. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 113-122). Seattle, WA: Hogrefe & Huber.

Kaplan, R. M., & Stone, A. A. (2013). Bringing the laboratory and clinic to the community: Mobile technologies for health promotion and disease prevention. *Annual Review of Clinical Psychology, 64*, 471-498.

Karger, P. (1925). Über den Schlaf des Kindes [About the child's sleep]. In A. Czerny (Ed.), *Abhandlungen aus der Kinderheilkunde und ihren Grenzgebieten. Beihefte zum Jahrbuch für Kinderheilkunde (Heft 5)* [Essays on pediatrics and its border areas: Supplements to the year book of pediatric, Vol. 5]. Berlin, Germany: Karger.

Kazdin, A. E. (1974). Reactive self-monitoring: The effects of response desirability, goal setting, and feedback. *Journal of Consulting and Clinical Psychology, 42*, 704-716.

Kenardy, J. A., Dow, M. G. T., Johnston, D. W., Newman, M. G., Thomson, A., & Taylor, C. B. (2003). A comparison of delivery methods of cognitive behavioural therapy for panic disorder: An international multicentre trial. *Journal of Consulting and Clinical Psychology, 71*, 1068-1075.

Kennedy, H. L. (2006). The history, science, and innovation of Holter technology. *Annals of Noninvasive Electrocardiology, 11*, 85-94.

Kenward, R. E. (2001). *A manual for wild life radio tagging*. London, U.K.: Academic Press.

Klingler, E. (1971). *Structure and functions of fantasy*. New York, NY: Wiley Interscience.

Ko, W. H., & Neuman, M. R. (1967). Implant biotelemetry and microelectronics: Report on developments in implant telemetry, associated problems, and the potential of microelectronics. *Science, 156,* 351-360.

Koval, P., & Kuppens, P. (2012). Changing emotion dynamics: Individual differences in the effect of anticipatory social stress on emotional inertia. *Emotion, 12*, 256-267.

Kubiak, T., & Hermanns, N. (2001). Ambulatory assessment of hypoglycaemia unawarness in type 1 diabetes. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment (pp.* 525-534). Seattle, WA: Hogrefe & Huber.

Kubiak, T., Hermanns, N., Schreckling, H. J., Kulzer, B., & Haak, T. (2004). Assessment of hypoglycaemia awareness using continuous glucose monitoring. *Diabetic Medicine, 21,* 487–490.

Kubiak, T., & Krog, K. (2012). Computerized sampling of experiences and behavior: Overview of hardware and software solutions. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 124-143). New York, NY: Guilford.

Kudielka, B. M., Broderick, J. E., & Kirschbaum, C. (2003). Compliance with saliva sampling protocols: Electronic monitoring reveals invalid daytime profiles in noncompliant subjects. *Psychosomatic Medicine, 65*, 313-319.

Kudielka, B. M., Gierens, A., Hellhammer, D. A., Wüst, S., & Schlotz, W. (2012). Salivary cortisol in ambulatory assessment. Some dos, some don'ts, and some open questions. Psychosomatic Medicine, 74, 418-431. doi:10.1097/PSY.0b013e31825434c7

Laporte, R. E., Montoye, H. J, & Caspersen, C. J. (1985). Health assessment of physical activity in epidemiologic research: Problems and prospects. *Public Health Reports, 100,* 131-146.

Larson, R., & Richards, M. (1994). *Divergent realities. The emotional lives of mothers, fathers, and adolescents.* New York: Basic Books.

Lauter, S. (1926). Zur Genese der Fettsucht [The genesis of obesity]. *Deutsches Archiv für Klinische Medizin, 150,* 315-365.

Leopold, C., & Schandry, R. (2001). Giving feedback to asthma patients. Ambulatory monitoring in patient education. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment* (pp. 505-523). Seattle, WA: Hogrefe & Huber Publishers.

Lewinsohn, P. M., & Atwood, G. E. (1969). Depression: A Clinical-Research Approach: The Case of Mrs. G. *Psychotherapy: Theory, Research & Practice, 6*, 166-171.

Lewinsohn, P. M., & Graf. M. (1973). Pleasant activities and depression. *Journal of Consulting and Clinical Psychology, 41*, 261-268.

Lewinsohn, P. M., & Libet, J. (1972). Pleasant events, activity schedules, and depression. *Journal of Abnormal Psychology, 79*, 291-295.

Lindsley, O. R. (1968). A reliable wrist counter for recording behavior rates. *Journal of Applied Behavior Analysis, 1*, 77-78.

Littler, W. A. (1979). Sleep and blood pressure: Further observations. *American Heart Journal, 97*, 35-37.

Littler, W. A., Honour, A. J., & Sleight, P. (1973). Direct arterial pressure and electrocardiogram during motor car driving. *British Medical Journal, 2*, 273-277.

Littler, W. A., Honour, A. J., & Sleight, P. (1974a). Direct arterial pressure, pulse rate and electrocardiogram during micturition and defecation. *American Heart Journal, 88*, 205-210.

Littler, W. A., Honour, A. J., & Sleight, P. (1974b). Direct arterial pressure, heart rate and electrocardiogram during human coitus. *Journal of Reproduction and Fertility, 40*, 321-333.

Littler, W. A., Honour, A. J., Sleight, P., & Stott, F. D. (1972). Continuous recording of direct arterial pressure and electrocardiogram in unrestricted man. *British Medical Journal, 3*, 76-78.

Littler, W. A., & Komsuoglu, B. (1989). Which is the most accurate method of measuring blood pressure? *American Heart Journal, 117*, 723-728.

Lord, R. D., Bellrose, F. C., & Cochran, W. W. (1962). Radiotelemetry of the respiration of a flying duck. *Science, 137,* 39-40.

Lorents, A. C. (1971). *Faculty activity analysis and planning models in higher education.* **(**Project PRIME report No. 6). Retrieved from http://eric.ed.gov/PDFS/ED055572.pdf

Malacrida, R., Bomio, D., Matathia, R., Suter, P. M., & Perrez, M. (1991). Computer-aided self-observation psychological stressors in an ICU. *International Journal of Clinical Monitoring and Computing, 8*, 201-205.

Mancia, G., Grassi, G., Pomidossi, G., Gregorini, L., Bertineri, G., … Zanchetti, A. (1983). Effects of blood-pressure measurement by the doctor on patient's blood pressure and heart rate. *The Lancet, 322*, 695-698.

Mancia, G., & Parati, G. (1993). Commentary on the revised British Hypertension Society protocol for evaluation of blood pressure measuring devices: A critique of aspects related to 24-hour ambulatory blood pressure measurement. *Journal of Hypertension, 11,* 595-597.

Marey, É. J. (1878). *La méthode graphique dans les sciences expérimentales et principalement en physiologie et en médecine* [The graphical method in the experimental sciences and particularly in physiology and medicin]. Paris: G. Masson. Retrieved from http://vlp.mpiwg-berlin.mpg.de/references?id=lit3585

Margraf, J., Taylor, C. B., Ehlers, A., Roth, W. T., & Agras, W. S. (1987). Panic attacks in the natural environment. *Journal of Nervous and Mental Disease, 175*, 558–565.

Mayo-Wells, W. J. (1963). The origins of space telemetry. *Technology and Culture, 4,* 499-514.

McCance, R. A., Luff, M. C., & Widdowson, E. E. (1937). Physical and emotional periodicity in women. *The Journal of Hygiene, 37*, 571-611.

MacCoby, E. E., Dowley, E. M., & Hagen, J. W. (1965). Activity level and intellectual functioning in normal preschool children. *Child Development, 36*, 761-770.

MacInnis, H. F. (1954). The clinical application of radioelectrocardiography. *Canadian Medical Association Journal, 70*, 574-576.

Maddison, R., & Ni Mhurchu, C. (2009). Global positioning system: A new opportunity in physical activity measurement. *International Journal of Behavioral Nutrition and Physical Activity, 6: 73*, 1-8. doi:10.1186/1479-5868-6-73

McFall, R.M. (1970). Effects of self-monitoring on normal smoking behavior. *Journal of Consulting and Clinical Psychology, 35,* 135-142.

McFall, R. M., & Hammen, C. L. (1971). Motivation, structure, and self-monitoring: Role of nonspecific factors in smoking reduction. *Journal of Consulting and Clinical Psychology, 37*, 80-86.

Mehl, M. R., & Conner, T. S. (Eds.). (2012). *Handbook of research methods for studying daily life*. New York, NY: Guilford.

Mehl, M. R., Pennebaker, J. W., Crow, M. D., Dabbs, J., & Price, J. H. (2001). The Electronically Activated Recorder (EAR): A device for sampling naturalistic daily activities and conversations. *Behavior Research Methods, Instruments, and Computers, 33,* 517-523.

Mehl, M. R., & Robins, M. L. (2012). Naturalistic observation sampling: The electronically activated recorder. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 176-192). New York, NY: Guilford.

Mehl, M. R., Robbins, M. L., & Deters, F. G. Naturalistic observation of healthrelevant social processes: The electronically activated recorder (EAR) methodology in psychosomatics. *Psychosomatic Medicine, 74*, 410-417.

Merrill, S. B., & Mech, L. D. (2003). The usefulness of GPS telemetry to study wolf circadian and social activity. *Wildlife Society Bulletin, 31*, 947-960.

Meuret, A. E., Wilhelm, F. H., Ritz, T., & Roth, W. T. (2008). Feedback of end-tidal pCO2 as a therapeutic approach for panic disorder. *Journal of Psychiatric research, 42*, 560-568.

Michel, G. (2007). Daily patterns of symptom reporting in families with adolescent children. *British Journal of Health Psychology, 12*, 245-260.

Mills Link, M. (1965). *Space medicine in project mercury*. (NASA History Series, Special Publication-4003). Retrieved from: http://history.nasa.gov/SP-4003/toc.htm

Montoye, H. J., & Taylor, H. L. (1984). Measurement of physical activity in population studies: A review. *Human Biology, 56*, 195-216.

Morris, N. M., & Udry, J. R. (1969). Depression of physical activity by contraceptive pills. [Abstract]. *American Journal of Obstetrics and Gynecology, 104*, 1012-1014.

Moskowitz, D. S., & Sadikaj, G. (2012). Event-contingent sampling. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 160-175). New York, NY: Guilford.

Münsterberg, H. (1892). Lust und Unlust [Lust and listlessness]. In H. Münsterberg (Ed.), *Beiträge zur experimentellen Psychologie* [Contributions to experimental psychology], (Vol. 4, pp. 216-238). Freiburg im Brsg: Mohr. Retrieved from http://vlp.mpiwg-berlin.mpg.de/library/data/lit38802?

Münsterberg, H. (1908). *On the witness stand: Essays on psychology and crime*. New York, NY: Doubleday. Retrived from http://www.all-about-psychology.com/support-files/hugo-munsterberg-essays-on-psychology-and-crime.pdf

Munsch, S., Meyer, A. H., Milenkovic, N., Schlup, B., Margraf, J. & Wilhelm, F. H. (2009). Ecological momentary assessment to evaluate cognitive-behavioral treatment for binge eating disorder. *International Journal of Eating Disorders, 42*, 648-657.

Myin-Germeys, I. (2012). Psychiatry. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 636-650). New York, NY: Guilford.

Myrtek, M. (2004). *Heart and emotion. Ambulatory monitoring studies in everyday life._Cambridge, MA: Hogrefe & Huber.*

Myrtek, M., Aschenbrenner, E., & Brügner, G. (2005). Emotions in everyday life: an ambulatory monitoring study with female students. *Biological Psychology, 68,* 237–255.

Myrtek, M., Brügner, G., Fichtler, A., König, K., Müller, W., Foerster, F., & Höppner, V. (1988). Detection of emotionally induced ECG changes and their behavioral correlates: A new method for ambulatory monitoring. *European Heart Journal, 9* (Supplement N), 55-60.

Myrtek, M., Brügner, G., & Müller, W. (1996a). Interactive monitoring and contingency analysis of emotionally induced ECG changes: Methodology and applications. In: Fahrenberg, J. & Myrtek, M. (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 115-127). Seattle, WA: Hogrefe & Huber.

Myrtek, M., Brügner, G., & Müller, W. (1996b). Validation studies of emotional, mental, and physical workload components in the field. In: Fahrenberg, J. & Myrtek, M. (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 287-304). Seattle, WA: Hogrefe & Huber.

National Audit Office (2006). *The electronic monitoring of adult offenders. Report by the Comptroller and Auditor General, HC 800, session 2005-2006.* Retrieved from: http://www.nao.org.uk/publications/0506/the_electronic_monitoring_of_a.aspx

Newman, M. G., Kenardy, J., Herman, S., & Taylor, C. B. (1996). The use of hand-held computers as an adjunct to cognitive-behavior therapy. *Computers in Human Behavior, 12*, 135-143.

Newman, M. G., Kenardy, J., Herman, S., & Taylor, C. B. (1997). Comparison of palmtop-computer-assisted brief cognitive-behavioral treatment to cognitive-behavioral treatment for panic disorder. *Journal of Consulting and Clinical Psychology, 65,* 178–183.

Newman, M. G., Consoli, A., & Taylor, C. B. (1999). A palmtop computer program for the treatment of generalized anxiety disorder. *Behavior Modification, 23*, 597-619.

Nezlek, J. B. (2008). An introduction to multilevel modeling. *Social and Personality Psychology Compass, 2*, 842–860.

Norland, C. C., & Semler, H. J. (1964). Angina pectoris and arrhythmias documented by cardiac telemetry. *Journal of the American Medical Association, 190*, 115-126.

Norton, M., Wonderlich, S. A., Myers, T., Mitchell, J. E., & Crosby, R. D. (2003). The use of palmtop computers in the treatment of bulimia nervosa. *European Eating Disorders Review, 11*, 231–242.

O’Brien, E., Asmar, R., Beilin, L., Imai, Y., Mallion, J. M., . . . Verdecchia, P. (2003). European Society of Hypertension recommendations for conventional, ambulatory and home blood pressure measurement. *Journal of Hypertension, 21*, 821–848.

O'Brien, E., Asmar, R., Beilin, L., Imai, Y., Mancia, G., . . . Verdecchia, P. (2005). Practice guidelines of the European Society of Hypertension for clinic, ambulatory and self blood pressure measurement. *Journal of Hypertension, 23*, 697–701.

O’Brien, E., Atkins, N., Stergiou, G., Karpettas, N., Parati, G., . . . Shennan, A. (2010). European Society of Hypertension international protocol revision 2010 for the validation of blood pressure measuring devices in adults. *Blood Pressure Monitoring, 15*, 23–38.

O'Brien, E., & O'Malley, K. (1990). Twenty-four-hour ambulatory blood pressure monitoring: A review of validation data. *Journal of Hypertension, 8* (suppl. 6), S11-S16

O'Brien, E., Petrie, J., Littler, W. A., de Swiet, M., Padfield, P. L., . . . Atkins, N. (1993). The British Hypertension Society Protocol for the evaluation of blood pressure measuring devices. *Journal of Hypertension, 11*(suppl. 2), S43-S63.

O’Brien, E., Waeber, B., Parati, G., Staessen, J., & Myers, M. G. (2001). European Society of Hypertension recommendations on blood pressure measuring devices. *British Medical Journal, 322*, 531–536.

Olson, W. C., & Cunningham, E. M. (1934). Time-sampling techniques. *Child Development, 5,* 41-58.

Omboni, S., Parati, G., Groppelli, A., Ulian, L., & Mancia, G. (1997). Performance of the AM-5600 blood pressure monitor: Comparison with ambulatory intra-arterial pressure. *Journal of Applied Physiology, 82*, 698-703.

Oorschot, M., Kwapil, T., Delespaul, P., & Myin-Germeys, I. (2009). Momentary assessment research in psychosis. *Psychological Assessment, 21*, 498–505.

Palmier-Claus J. E., Myin-Germeys, I., Barkus, E., Bentley, L., Udachina, A., . . . Dunn, G. (2011). Experience sampling research in individuals with mental illness: Reflections and guidance. *Acta Psychiatrica Scandinavica, 123*, 12–20.

Parati, G., Ongaro, G., Bilo, G., Glavina, F., Castiglioni, P., Di Rienzo, M., & Mancia, G. (2003). Non-invasive beat-to-beat blood pressure monitoring: New developments. *Blood Pressure Monitoring, 8,* 31-35.

Parfenov, G. P. (1975). Biological guidelines for future space research. In M. Calvin, & O. G. Gazenko (Eds.), *Foundations of space biology and medicine (Vol. 2, Book 2). Ecological and physiological bases of space biology and medicine* (pp. 707- 739). Washington, DC: Scientific and Technical Information Office, NASA.

Parker, C. S., Breakell, C. C., & Christopherson, F. (1953). The radioelectrophysiologram: Radio transmission of electrophysiological data from the ambulant and active patient. *Lancet, 1, 1285-1288.*

Pawlik, K., & Buse, L. (1982). Rechnergestützte Verhaltensregistrierung im Feld: Beschreibung und erste psychometrische Überprüfung einer neuen Erhebungsmethode [Computer-based behavior registration in the field: Description and first psychometric evaluation of a new recording method]. *Zeitschrift für Differentielle und Diagnostische Psychologie, 3*, 101-118.

Pawlik, L., & Buse, L. (2003). *AMBU II: Ambulatory monitoring and behavior test unit für ambulante Psychodiagnostik. Handbuch*. Göttingen, Gerrmany: Hogrefe.

Payne, R.L., & Rick, J.T. (1986). Heart rate as an indicator of stress in surgeons and anaesthetists. *Journal of Psychosomatic Research, 30*, 411-420.

Pellerin, G. (2006). United States updates global positioning system technology: New GPS satellite ushers in a range of future improvements. *Washington File, February 3, 2006* (Newsletter of the U. S. American Government). Retrieved from http://www.america.gov/st/washfile-english/2006/February/20060203125928lcnirellep0.5061609.html

Perkonigg, A., Baumann, U., Reicherts, M., & Perrez, M. (1993). Soziale Unterstützung und Belastungsverarbeitung: Eine Untersuchung mit computergestützter Selbstbeobachtung [Social support and coping. A computer supported self-observation study]. In A. Laireiter (Hrsg.), *Soziales Netzwerk und soziale Unterstützung* (S. 128-140). Bern, Switzerland: Hans Huber.

Perrez, M., Berger, R., & Wilhelm, P. (1998). Die Erfassung von Belastungserleben und Belastungsverarbeitung in der Familie: Self-Monitoring als neuer Ansatz [Assessment of stress and coping in the family: Self monitoring as a new approach]. *Psychologie in Erziehung und Unterricht, 45,* 19-35.

Perrez, M., & Reicherts, M. (1987). Coping behavior in the natural setting: a method of computer-aided self-observation. In H. P. Dauwalder, M. Perrez, & V. Hobi (Eds*), Controversial issues in behavior modification. Annual series of European research in behavior therapy* (Vol. 2, pp. 127-137). Lisse, The Netherlands: Swets & Zeitlinger.

Perrez, M., & Reicherts, M. (1992). *Stress, coping, and health: A situation-behavior approach. Theory, methods, applications.* Seattle, WA: Hogrefe & Huber.

Perrez, M., & Reicherts, M. (1996). A computer-assisted self-monitoring procedure for assessing stress-related behavior under real life conditions. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 51-67). Seattle, WA: Hogrefe & Huber.

Perrez, M., & Schöbi, D. (2001). Soziales Coping in der Selbst- und in der Fremdperspektive [Self- and Other-Perspective on Social Coping] In S. Walper & R. Pekrun (Hrsg.), *Familie und Entwicklung. Aktuelle Perspektiven der Familienpsychologie* (S. 219-237). Göttingen: Hogrefe.

Perrez, M., Schoebi, D., & Wilhelm, P. (2000). How to assess social regulation of stress and emotion in daily family life? A computer-assisted family self-monitoring system (FASEM-C). *Clinical Psychology and Psychotherapy, 7*, 326-339.

Perrez, M., Watzek, D., Michel, G., Schoebi, D., Wilhelm, P., & Hänggi, Y. (2005). Facets of emotion regulation in families with adolescents: A new research approach. In H.P. Kriesi, P. Farago, M. Kohli, & M. Zarin-Nejadan (Eds.), *Contemporary Switzerland. Revisting the special case* (pp. 61-80). Houndmills, U.K.: Palgrave Macmillan.

Perrez, M., Wilhelm, P., Schoebi, D., & Horner, M. (2001). Simultaneous computer assisted assessment of causal attribution and social coping in families. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 25-43). Seattle, WA: Hogrefe & Huber.

Piaget, J. (1926). *La représentation du monde chez l'enfant* [The child's conception of the world]. Paris: Presses Universitaires de France.

Piasecki, T. M., Hufford, M. R., Solhan, M., & Trull, T. J. (2007). Assessing clients in their natural environments with electronic diaries: Rationale, benefits, limitations, and barriers. *Psychological Assessment, 19*, 25–43

Pickering, T. G. (1991). *Ambulatory monitoring and blood pressure variability*. London, UK: Science Press.

Pickering, T. G., Davidson, K., Gerin, W., & Schwartz, J. E. (2002). Masked hypertension. *Hypertension, 40*, 795-796.

Pickering, T. G., James, G. D., Boddie, C., Harshfield, G. A., Blank, S., & Laragh, J. H. (1988). How common is white coat hypertension? *Journal of the American Medical Association, 259,* 225-228.

Pino, J., Martinez-Santos, R., Moreno, M. I., & Padilla, C. (2007). Automatic analysis of football games using GPS on real time. *Journal of Sports Science and Medicine, Suppl. 10*, 6 – 11.

Pollit, L. L., Almond, C. H., & Logue, J. T. (1968). Dynamic electrocardiography with strenuous exertion at high altitudes. *American Heart Journal, 75* (4), 570-572.

Porter, M. M., & Whitton, M. J. (2002). Assessment of driving With the global positioning system and video technology in young, middle-aged, and older drivers. Journal of *Gerontology: Medical Sciences, 57A*, M578–M582.

Preyer, W. T. (1889/1882). *The Mind of the Child, Part II. The Development of the Intellec*t [Die Seele des Kindes: Beobachtungen über die geistige Entwicklung des Menschen in den ersten Lebensjahren]. New York, NY: Appleton & Co.

Retrieved from http://www.gutenberg.org/files/19549/19549-h/19549-h.htm#toc_189

Proshansky, H. M., Ittelson, W.H., & Rivlin, L G. (Eds.). (1976). *Environmental Psychology. People and their physical settings* (2nd ed.). New York, NY: Holt, Rinehart & Winston.

Przeworski, A., & Newman, M.G. (2004). Ambulatory computer-assisted group therapy for generalized social phobia. *Journal of Clinical Psychology, 60*, 179-188.

Pyles, M. K., Stolz, H. R., & Macfarlane, J. W. (1935.) The accuracy of mothers' reports on birth and developmental data. *Child Development, 6*, 165-176.

Rau, R. (2001). Objective characteristics of jobs affect blood pressure at work, after work, and at night. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 361-386). Seattle, WA: Hogrefe & Huber.

Rau, R., & Richter, P. (1996). Psychophysiological analysis of strain in real life work situations. In J. Fahrenberg & M. Myrtek (Eds.). *Ambulatory Assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 271-285). Seattle, WA: Hogrefe & Huber.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models. Applications and data analysis methods* (2nd ed.). Thousand Oaks: Sage.

Redelmeier, D. A., & Kahneman, D. (1996). Patients' memories of pain medical treatments: Real-time and retrospective evaluations of two minimally invasive procedures. *Pain, 66*, 3–8.

Redelmeier, D. A., Katz, J., & Kahneman, D. (2003). Memories of colonoscopy: A randomized trial. *Pain, 104*, 187–194.

Reicherts, M., Salamin, V., Maggiori C., & Pauls, K. (2007). The learning affect monitor (LAM): A computer-based system integrating dimensional and discrete assessment of affective states in daily life. *European Journal of Psychological Assessment, 23*, 268–277.

Reis, H. T. (2012). Why researchers should think "real-world": A conceptual rationale. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 3-21). New York, NY: Guilford.

Reis, H. T., & Gable, S. L. (2000). Event-sampling and other methods for studying everyday experience. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 190-222). Cambridge, UK: Cambridge University Press.

Riddoch, C. J., Mattocks, C., Deere, K., Saunders, J., Kirkby, J., … Ness, A. R. (2007). Objective measurement of levels and patterns of physical activity. *Archives of Disease in Childhood, 92,* 963-969.

Robinson, M. D., & Clore, G. L. (2002). Belief and feeling: Evidence for an accessibility model of emotional self-report. *Psychological Bulletin, 128*, 934–960.

Rodgers, A. R., Rempel, R. S., & Abraham, K. F. (1996). A GPS-based telemetry system. *Wildlife Society Bulletin, 24*, 559-566.

Roghmann, K. J., & Haggerty, R. J. (1972). The diary as a research instrument in the study of health and illness behavior: Experiences with a random sample of young families. *Medical Care, 10,* 143-163.

Rosander, A. C., Guterman, H. E., & McKeon, A. J. (1958). The use of random work sampling for cost analysis and control. *Journal of the American Statistical Association, 53*(No. 282), 382-397.

Rosmalen, J. G. M., Wenting, A. G. M., Roest, A. M., de Jonge, P., & Bos, E. H. (2012). Revealing causal heterogeneity using time-series analysis of ambulatory assessments: Application to the association between depression and physical activity following myocardial infarction. *Psychosomatic Medicine, 74*, 377-386.

Roth, W. T., Tinklenberg, J. R., Doyle, C. M., Horvath, T. B., & Kopell, B. S. (1976). Mood states and 24-hour cardiac monitoring. *Journal of Psychosomatic Research, 20*, 179-186.

Rothfeld, E. L., Bernstein, A., Crews, A. H., Parsonnet, V., & Zucker, R. (1965). Telemetric monitoring of arrhythmias in acute myocardial infarction. *American Journal of Cardiology, 15*, 38-44.

Sadeh, A. (2011). The role and validity of actigraphy in sleep medicine: An update. *Sleep Medicine Reviews, 15*, 259-267.

Sadeh, A., Hauri, P. J., Kripke, D. F., & Lavie, P. (1995). The role of actigraphy in the evaluation of sleep disorders. *Sleep, 18*, 288-302.

Sanchez, V., & Lewinsohn, P. M. (1980). Assertive behavior and depression. *Journal of Consulting and Clinical Psychology, 48*, 119-120.

Sanders, J. S., & Martt, J. M. (1966). Dynamic electrocardiography at high altitude. *Archives of Internal Medicine, 118*, 132-138.

Sanderson, G. C. (1966). The study of mammal movements: A review. *The Journal of Wildlife Management, 30*, 215-233.

Sanderson, G. C., & Sanderson, B. C. (1964). Radio-Tracking Rats in Malaya: A Preliminary Study. *The Journal of Wildlife Management, 28*, 752-768.

Santangelo, P., Bohus, M., & Ebner-Priemer, U. W. (in press). Ecological momentary assessment in borderline personality disorder: A review on recent findings and methodological challenges. *Journal of Personality Disorders,* e-pub ahead of print.

Sartory, G., Roth, W. T., & Kopell, M. L. (1992). Psychophysiological assessment of driving phobia. *Journal of Psychophysiology, 6,* 311–320.

Scherer, K. R., & Ceschi, G. (1997). Lost luggage: A field study of emotion-antecedent appraisal. *Motivation and Emotion, 21*, 211–235.

Schoebi, D. (2004). *Konfliktregulation im Alltag von Familien. Konflikte in Familien als Prozesse sozialer Belastungsbewältigung* [Conflict regualtion in families' everyday life. Conflicts in families as processes of social coping]. Berlin, Germany: Tenea Verlag.

Schoebi, D. (2008). The coregulation of daily affect in marital relationships. *Journal of Family Psychology, 22*, 595-604.

Schoebi, D., Wang, Z., Ababkov, V., & Perrez, M. (2010). Affective interdependence in married couples' daily lives: Are there cultural differences in partner effects of anger? *Family Science, 1*, 83-92.

Schlotz, W. (2012). Ambulatory psychoneuroendocrinology: Assessing salivary cortisol and other hormones in daily life. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 193-209). New York, NY: Guilford.

Schmidt, T., & Jain, A. (1996). Continous assessment of finger blood pressure and other haemodynamic variables. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 189-213). Seattle, WA: Hogrefe & Huber.

Schneider, R. A. (1968). A fully automatic portable blood pressure recorder. *Journal of Applied Physiology, 24,* 115-118.

Schneider, R. A., & Costiloe, J. P. (1975). Twenty-four hour automatic monitoring of blood pressure and heart rate at work and at home. *American Heart Journal, 90*, 695-702.

Schulman, J. L., Stevens, T. M., & Kupst, M. J. (1977). The biomotometer: A new device for the measurement and remediation of hyperactivity. *Child Development, 48,* 1152-1154.

Schutz, Y., & Chambaz, A. (1997). Could a satellite-based navigation system (GPS) be used to assess the physical activity of individuals on earth? *European Journal of Clinical Nutrition, 51*, 338-339.

Schwarz, N. (2007). Retrospective and concurrent self reports: The rationale for real-time data capture. In A. A. Stone, S. Shiffman, A. A. Atienza, & L. Nebeling (Eds.), *The science of real-time data capture: Self reports in health research* (pp. 11–26). New York, NY: Oxford University Press.

Schwarz, N. (2012). Why researchers should think “real-time”: A cognitive rationale. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 22-42). New York, NY: Guilford.

Schwitzgebel, R. L. (1968). Survey of electromechanical devices for behavior modification. *Psychological Bulletin, 70*, 444-459.

Scollon, C. N., Kim-Prieto, C., & Diener, E. (2003). Experience sampling: Promises and pitfalls, strengths and weaknesses. *Journal of Happiness Studies, 4,* 5-34.

Shiffman, S. (2007). Designing protocols for ecological momentary assessment. In A. A. Stone, S. Shiffman, A. A. Atienza, & L. Nebeling (Eds.), *The science of real-time data capture. Self reports in health research* (pp. 27–53). New York, NY: Oxford University Press.

Shiffman, S., Fischer, L. A., Paty, J. A., Gnys, M., Hickcox, M., & Kassel, J. D. (1994). Drinking and smoking: A field study of their association. *Annals of Behavioral Medicine, 16*, 203-203.

Shiffman, S., Stone, A. A., & Hufford, M.R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology, 4*, 1–32.

Simonov, P. V. (1975). Psychophysiological stress of space flight. In M. Calvin, & O. G. Gazenko (Eds.), *Foundations of space biology and medicine (Vol. 2, Book 2). Ecological and physiological bases of space biology and medicine* (pp. 549- 570). Washington, DC: Scientific and Technical Information Office, NASA.

Singer, J. D., & Willet, J. B. (2003). *Applied longitudinal data analysis. Modeling change and event occurrence*. New York, NY: Oxford University Press.

Slagle, A. K. (1965). Designing systems for the field. *BioScience*, 109-112.

Smith, W. B., & Safer, M. A. (1993). Effects of present pain level on recall of chronic pain and medication use. *Pain, 55*, 355–361.

Snijders, T. A. B., & Bosker, R. J. (1999). *Multilevel analysis. An introduction to basic and advanced multilevel modelling*. London: Sage.

Sokolow, M., Werdegar, D., Kain, H. K., & Hinman, A. T. (1966). Relationship between level of blood pressure measuring casually and by portable recorders and severity of complications in essential hypertension. *Circulation, 34*, 279-298.

Sorbi, M. J., Honkoop. P. C., & Godaert, G. L. R. (1996). A signal-contingent computer diary for the assessment of psychological precedents of the migraine attack. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 403-412). Seattle, WA: Hogrefe & Huber.

Sorbi, M. J., Mak, S. B., Houtveen, J. H., Kleiboer, A. M., & van Doornen, L. J. P. (2007). Mobile Web-based monitoring and coaching: feasibility in chronic migraine. *Journal of Medical Internet Research, 9*(5). doi:http://www.jmir.org/2007/5/e38/

Stadler, G., Snyder, K. A., Horn, A. B., Shrout, P. E., Bolger, N. P. (2012). Close relationships and health in daily life: A review and empirical data on intimacy and somatic symptoms. *Psychosomatic Medicine, 74*, 398-409.

Stanley, N. (2003). Actigraphy in human psychopharmacology: A review. *Human Psychopharmacology: Clinical and Experimental, 18*, 39–49.

Stanton, A., & O'Brien, E. (1993). Noninvasive 24 hour ambulatory blood pressure monitoring: current status. *Postgraduate Medical Journal, 69*, 255-267.

Stephan, E., Mutz, G., Feist, A., & Weiß, R. K. (2001). Some new developments in ambulatory assessment devices. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 561-568). Seattle, WA: Hogrefe & Huber.

Steptoe, A. (2001). Ambulatory monitoring of blood pressure in daily life: A tool for investigating psychosocial processes. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 257-269). Seattle, WA: Hogrefe.

Stern, C., & Stern, W. (1900-1918). *Die Tagebücher. Elektronische Abschrift der unveröffentlichten Tagebücher aus dem Nachlaß* [The diaries. Electronic copy of the unpublished diaries from the literary estate]. Nijmegen, The Netherlands: Max Planck Institute for Psycholinguistics.

Stern, E. (1986). *Reaktivitätseffekte in Untersuchungen zur Selbstprotokollierung des Verhaltens im Feld.* [Reactivity effects in studies which assess self-recorded behaviour in the field]. Frankfurt am Main, Germany: Peter Lang.

Stone, A. A., & Shiffman, S. (1994). Ecological momentary assessment (EMA) in behavorial medicine. *Annals of Behavioral Medicine, 16*, 199-202.

Stone, A. A., Shiffman, S., Atienza A. A., & Nebeling L. (2007). Historical roots and rationale of ecological momentary assessment. In A. A. Stone, S. Shiffman, A. A. Atienza, & L. Nebeling (Eds.), *The science of real-time data capture: Self reports in health research* (pp. 3–10). New York, NY: Oxford University Press.

Stone, A. A., Shiffman, S., Schwartz, J. E., Broderick, J. E., & Hufford, M. R. (2002). Patient non-compliance with paper diaries. *British Medical Journal, 324*, 1193.

Stone, A. K. (1908). The home treatment of tuberculosis. *Boston Medical and Surgical Journal, 159*, 393-399.

Stunkard, A. J. (1958). Physical activity, emotions, and human obesity. *Psychosomatic Medicine, 20*, 366-372.

Sudman, S., & Ferber, R. (1971). Experiments in obtaining consumer expenditures by diary methods. *Journal of the American Statistical Association, 66*, 725-735.

Swenson, L. S., Grimwood, J. M., & Alexander, C. C. (1989). This new ocean: A history of project mercury. NASA History Series, Special Publication-4201. Retrieved from http://www.hq.nasa.gov/office/pao/History/SP-4201/toc.htm

Szalai, A. (1966). Trends in comparative time-budget research. *American Behavioral Scientist, 9*, 3-8.

Szalai, A. (Ed.) (1972). *The use of time: Diary activities of urban and suburban populations in twelve countries*. The Hague, The Netherlands: Mouton & Co.

Szymanski, J. S, (1914). Eine Methode zur Untersuchung der Ruhe- und Aktivitätsperioden bei Tieren [A method to investigate periods of rest- and activity in animals]. *Pflügers Archiv für die gesamte Physiologie der Menschen und der Tiere, 158,* 343–385.

Szymanski, J. S. (1918). Aktivität und Ruhe bei Tieren und Menschen [Activity and rest in animals and humans]. *Zeitschrift für Allgemeine Physiologie, 18*(2), 105-162.

Szymanski, J. S. (1922). Aktivität und Ruhe bei den Menschen [Activity and rest in humans]. *Zeitschrift für Angewandte Psychologie, 20*, 192-222.

Taggart, P., Gibbons, D., & Somerville, W. (1969). Some effects of motorcar driving on the normal and abnormal heart. *British Medical Journal, 4*, 130-134.

Taylor, C. B., Agras, W. S., Losch, M., Plante, T. G., & Burnett, K. (1991). Improving the effectiveness of computer-assisted weight loss. *Behavior Therapy, 22*, 229-236.

Taylor, C. B., Fried, L., & Kenardy, J. (1990). The use of a real-time computer diary for data acquisition and processing. *Behaviour Research and Therapy, 28*, 93-97.

Taylor, C. B., Kraemer, H. C., Bragg, D. A., Miles, L. E., Rule, B., Savin, W. M., & DeBusk, R. F. (1982). A new system for long-term recording and processing of heart rate and physical activity in outpatients. *Computers and Biomedical Research, 15*, 7-17.

Taylor, C. B., Telch, M. J., & Havvik, D. (1983). Ambulatory heart rate changes during panic attacks. *Journal of Psychiatric Research, 17*, 261-266.

Teicher, M. H. (1995). Actigraphy and motion analysis: New tools for psychiatry. *Harvard Review of Psychiatry, 3*, 18–35.

Tennen, H., Affleck, G., & Armeli, S. (2005). Personality and daily experience revisited. *Journal of Personality, 73*, 1465-1483.

Tester, J. R., & Heezen, K. L. (1965). Deer response to a drive census determined by radio tracking. *BioScience, 15*, 100-104.

Thiele, C., Laireiter, A.-R., & Baumann, U. (2002). Diaries in clinical psychology and psychotherapy: A selective review. *Clinical Psychology and Psychotherapy, 9*, 1–37.

Tiedemann, D. (1786). Beobachtungen über die Entwickelung der Seelenfähigkeiten bei Kindern [Observations concerning the development of psychic capabilities of children]. *Hessische Beiträge zur Gelehrsamkeit und Kunst, 6,* 313-333; *7, 486-502.* Retrieved from http://archiv.ub.uni-marburg.de/eb/2010/0300/view.html

Thompson, W. G. (1913). Efficiency in nursing. *Journal of the American Medical Association, 61,* 2146-2149.

Thomson, R. H. (1930). An experimental study of memory as influenced by feeling tone. *Journal of Experimental Psychology, 13*, 462-468.

Thorndike, E. L. (1937). How we spend our time and what we spend it for. *The Scientific Monthly, 44,* 464-469.

Totterdell, P. & Folkard, S. (1992). In situ repeated measures of affect and cognitive performance facilitated by use of a hand-held computer. *Behavior Research Methods, Instruments and Computers, 24*, 545-553.

Tov, W., & Scollon, C. (2012). Cross-cultural research. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 539-552). New York, NY: Guilford.

Trull, T. J., & Ebner-Priemer, U. W. (2009). Using Experience Sampling Methods/Ecological Momentary Assessment (ESM/EMA) in Clinical Assessment and Clinical Research: Introduction to the Special Section. *Psychological Assessment, 21*, 457-462.

Trull, T. J., & Ebner-Priemer, U. W. (2013). Ambulatory Assessment*. Annual Review of Clinical Psychology, 9,* 151-176. doi:10.1146/annurev-clinpsy-050212-185510

Tryon W. W. (1991). *Activity measurement in psychology and medicine*. New York, NY: Plenum.

Tryon, W. W., Tryon, G. S., Kazlausky, T., Gruen, W., & Swanson, J. M. (2006). Reducing hyperactivity with a feedback actigraph: Initial findings. *Clinical Child Psychology and Psychiatry, 11*, 607-617.

Tunnell, G. B. (1977). Three dimensions of naturalness: An expanded definition of field research. *Psychological Bulletin, 84,* 426-437.

van Marken Lichtenbelt, W. D., Daanen, H. A. M., Wouters, L., Fronczek, R., Raymann, R. J. E. M., ... , Van Someren, E. J. W. (2006). Evaluation of wireless determination of skin temperature using iButtons. *Physiology and Behavior, 88*, 489–497.

Verbrugge, L. M. (1980). Health diaries. *Medical Care, 18,* 73-95.

Vermont Center for Geographic Information (VCGI) (2005). *Vermont GPS Guidelines. VGIS Handbook, Part 3 - Guidelines (Section L).* Retrieved from http://www.vcgi.org/techres/standards/partiii_section_l.doc

Wagner, J., Tennen, H., & Wolpert, H. (2012). Continuous glucose monitoring: A review for behavioral researchers. *Psychosomatic Medicine, 74*, 356-365.

Wallace, D. B., Franklin, M. B., & Keegan, R. T. (1994). The observing eye: A century of baby diaries. *Human Development, 37,* 1-29.

Ware, R. W., &. Kahn, A. R. (1963). Automatic indirect blood pressure determination in flight. *Journal of Applied Physiology, 18*, 210-214.

Webb, E. J., Campbell, D. T., Schwartz, R. D., & Sechrest, L. (1966). *Unobtrusive measures: Nonreactive research in the social sciences.* Oxford, England: Rand McNally.

West, J. B. (2000). Physiology of a microgravity environment. Historical perspectives: Physiology in microgravity. *Journal of Applied Physiology, 89,* 379–384..

West, J. B. (2001). Historical aspects of the early Soviet-Russian manned space program. *Journal of Applied Physiology, 91*,1501-1511.

Wheeler, B. W., Cooper, A. R., Page, A. S., & Russell, J. (2010). Greenspace and children's physical activity: A GPS/GIS analysis of the PEACH project. *Preventive Medicine, 51,* 148–152.

Wheeler, L., & Nezlek, J. (1977). Sex differences in social participation. *Journal of Personality and Social Psychology, 38*, 742-754.

Wheeler, L., & Reis, H. T. (1991). Self-recording of everyday life events: Origins, types, and uses. *Journal of Personality, 59*, 339-354.

Wichers, M. C., Myin-Germeys, I., Jacobs, N., Peeters, F., Kenis, G., ... van Os, J. (2007). Evidence that moment-to-moment variation in positive emotions buffer genetic risk for depression: A momentary assessment twin study. *Acta Psychiatrica Scandinavica, 115*, 451–457.

Wiehe, S. S., Hoch, S., Liu, G., Carroll, A., Wilson, J., & Fortenberry, J. (2008). Adolescent travel patterns: Pilot data indicating distance from home varies by time of day and day of week. *Journal of Adolescent Health, 42*(4), 418-420.

Wilhelm, F. H., & Grossman, P. (2010). Emotions beyond the laboratory: Theoretical fundaments, study design, and analytic strategies for advanced ambulatory assessment. *Biological Psychology, 84*, 552–569.

Wilhelm, F. H., Grossman, P., & Mueller, M. (2012). Integrative ambulatory and laboratory psychophysiology: Assessing psychology in the real world and in the lab. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 210-234). New York, NY: Guilford.

Wilhelm, F. H., Pfaltz, M. C., Grossman, P. (2006). Continuous electronic data capture of physiology, behavior and experience in real life: Towards ecological momentary assessment of emotion. *Interaction with Computers, 18*, 171–186.

Wilhelm, F. H., & Roth, W. T. (1996). Ambulatory assessment of clinical anxiety. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment. Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 317-345). Seattle, WA: Hogrefe & Huber.

Wilhelm, F. H., & Roth, W. T. (1997). Acute and delayed effects of alprazolam on flight phobics during exposure. *Behaviour Research and Therapy, 35*, 831–841.

Wilhelm, F. H., & Roth, W. T. (1998). Taking the laboratory to the skies: Ambulatory assessment of self-report, autonomic, and respiratory responses in flying phobia. *Psychophysiology, 35*, 596–606.

Wilhelm, P. (2001). A multilevel approach to analyze ambulatory assessment data: An examination of family members' emotional states in daily life. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 173-189). Seattle, WA: Hogrefe & Huber.

Wilhelm, P. (2004). *Empathie im Alltag von Paaren. Akkuratheit und Projektion bei der Einschätzung des Befindens des Partners* [Empathy in couples' everyday lives: Accuracy and projection in judging the partner's feelings]. Bern: Huber.

Wilhelm, P., & Perrez, M. (2004). How is my partner feeling in different daily-life settings? Accuracy of spouses' judgements about their partner's feelings at work and at home. *Social Indicators Research, 67*, 183-246.

Wilhelm, P., Perrez, M., & Pawlik, K. (2012). Conducting research in daily life: A historical review. In M. R. Mehl & T. S. Conner (Eds.), *Handbook of research methods for studying daily life* (pp. 62-86). New York, NY: Guilford.

Wilhelm, P., & Schoebi, D. (2007). Assessing mood in daily life. Structural validity, sensitivity to change, and reliability of a short-scale to measure three basic dimensions of mood. *European Journal of Psychological Assessment, 23*, 258–267.

Wilkinson, G. (1843). Some Account of the Natron Lakes of Egypt; In a Letter to W. R. Hamilton, Esq. *Journal of the Royal Geographical Society of London, 13*, 113-118.

Wisbey, B., Montgomery, P. G., Pyne, D. B., & Rattray, B. (2009). Quantifying movement demands of AFL football using GPS tracking. *Journal of Science and Medicine in Sport, 13*(5), 531-536.

Wisconsin Department of Natural Resources (2001). *Comparing Global Positioning System (GPS) tools. Selecting the right tool for the job*. Retrieved from http://dnr.wi.gov/maps/gis/documents/gps_tools.pdf

Yarows, S. A., Julius, S., & Pickering, T. G. (2000). Home blood pressure monitoring. *Archives of Internal Medicine, 160,* 1251-1257.

Yuganov, Ye. M., & Kopanev, V. I. (1975). Physiology of the sensory sphere under spaceflight conditions. In M. Calvin, & O. G. Gazenko (Eds.), *Foundations of space biology and medicine (Vol. 2, Book 2). Ecological and physiological bases of space biology and medicine* (pp. 571-599). Washington, DC: Scientific and Technical Information Office, NASA.

Zanstra, Y. J., & Johnston, D. W. (2011). Cardiovascular reactivity in real life settings: Measurement, mechanisms and meaning. *Biological Psychology, 86*, 98–105.

Zuidema, G. D., Edelberg, R., & Salzman, E. W. (1956). A device for indirect recording of blood pressure. *Journal of Applied Physiology, 9,* 132-134.