in itself and may also provide useful applied information, for example, for shielding, replacing, and/or compensating magnetic fields as countermeasures. We had earlier learned that an approximate 7-day periodicity recorded in decades of around-the-clock measurements of HR is amplified in the presence and dampened in the absence of the same frequency in solar wind speed (Cornélissen et al. 1996). We owe these findings to the least squares of Gauss, who developed the method – to all of Europe's attention – to locate the "lost" asteroid Ceres in 1801. The method again proved useful to show that our heart and brain depend on our cosmos in more ways than sunlight and temperature (Halberg et al. 2003).

Conclusion. Self-surveillance and self-experimentation pertain to human health maintenance and the prevention of disease in its societal as well as classical aspects. A chronomic analysis of data from self-experimentation reveals interactions (time-specified feedsidewards) that account for the way we are affected by tangible physical environmental factors, so that one may try to elucidate mechanisms of diseases of individuals and of society for a broader-than-individual, also societal prehabilitation. Society has to "pay": in one way, by the family of affected individuals or by insurance premiums; in more ways than financially, for the care of every massive stroke that leaves the unfortunate survivors unable to care for themselves. Society faces an even greater bill, again more than financially, after each act of terror or war. This is the main challenge. The purpose of chronomics is to stray far beyond the scope of currently accepted limits for science and to tackle spirituality and "weather," not only on Earth but, since it affects us on Earth, also in extraterrestrial space. As to spirituality, "Things should be made as simple as possible but no simpler," as Einstein said. As to the weather, the effect of at least some unseen (nonphotic) aspects of the broader "weather" can be detected in ourselves. We gain some confidence from seeing wobbly signatures of geo- and/or heliomagnetics, as a near-week, a near-year and/or a transyear, in our physiology (BP and HR) and pathology (myocardial infarction).

NOTES

1. Dr. Barbara Schack died tragically on 24 July, 2003; memorial tribute in *Neuroendocrinology Letters* 2003, vol. 24, pp. 355–80. This note is also dedicated to her memory.

2. Each point made in this commentary is documented with figures based on data now published in Halberg et al. (2003).

Why does self-experimentation lead to creative ideas?

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Abstract: According to a multivariate approach on creativity, self-experimentation may well provide many of the conditions that allow for new ideas to occur. This research method is valuable in particular because the researcher's high level of participation in the search for a solution fosters the involvement of the necessary cognitive skills and conative traits.

Creative thinking involves the generation of new, original ideas that have value. Recent work on creativity proposes a multivariate approach in which cognitive, conative, and environmental factors combine interactively to yield creativity (Lubart 1999; Lubart et al. 2003; Sternberg & Lubart 1995). Cognitive factors include intellectual abilities such as selective encoding, selective comparison, and selective combination skills, as well as domain- and task-relevant knowledge. Conative factors refer to personality traits, such as risk taking, tolerance of ambiguity, perseverance, and openness, as well as intrinsic and extrinsic motivation. Environmental factors provide a setting that can stimulate and support the development of new ideas or, on the contrary, inhibit and devalue creative work.

Roberts proposes that self-experimentation is a powerful heuristic for creative thinking, and in particular, for generating new ideas. The main part of the target article presents the findings and new theories that resulted from self-experimentation. However, what makes self-experimentation special, compared to regular experimental methods? According to Roberts, being your own guinea pig has several advantages. First, it is cheaper and simpler to be your own subject. This can facilitate testing one's hypotheses and advance research quickly. Second, you can implement difficult-to-conduct methodologies, such as longitudinal research over months or years. Therefore, self-experimentation can facilitate creative thinking because it allows one to test difficult, perhaps crazy or long-shot hypotheses. Clearly, scientists tend to think twice about engaging resources in tests of hypotheses that offer little chance of success. The main benefit of self-experimentation is therefore to reduce the "opportunity cost" of testing creative ideas. This is not, however, a strong argument for the benefits of self-experimentation on idea generation; we can suppose that being able to test ideas cheaply allows one to entertain a wider set of ideas. But these ideas need to be generated at some point.

The potential contribution of self-experimentation to idea generation remains largely unexplored. We can, however, analyze Roberts' examples from the vantage point of research on creativity and build a case for the value of self-experimentation for creative idea generation. First, self-experimentation seems to facilitate selective encoding (noticing the relevance of information for one's task), selective comparison (observing similarities between different fields which clarify the problem), and selective combination (combining various elements of information which, joined together, will form a new idea). When a person has a specific question or issue in mind, he or she tends to see the world through "task-relevant" lenses.

The examples of self-experimentation proposed in the target article suggest that it is a 24-hour job to be both the subject and the experimenter. Consider Roberts' trip to Paris. Facing the culinary delights of French cuisine, he was curiously not very hungry. He noticed the oddity of this situation, perhaps, due in particular to his ongoing self-experimentation about weight loss. Then, he compared the culinary events of his Paris trip to those of his everyday life in the States. This selective comparison was facilitated, perhaps, because it was a within-subject affair. In fact, the novel taste of Parisian soft drinks was the distinctive element. Roberts happened to read prior to his trip a report about the novel taste of saccharin in experiments with rats. This previous knowledge made a selective combination process possible.

Self-experimentation can also facilitate creative idea generation by promoting certain conative factors for creativity. Most important, Roberts' examples of self-experimentation have a common feature: they all concern problems that Roberts considered to be personally important, namely, trouble sleeping, mood management, or losing weight. Roberts was therefore highly motivated to solve these self-engaging problems. He was willing to devote substantial time and effort to pursue possible solutions that could improve his life. He was intrinsically motivated, which has been shown to facilitate creative thinking. When he observed results in his personal quest that seemed odd, or contradictory, he lived with this state of ambiguity, and he continued to pursue his experiments because the possibility of finding a solution to his problems was worth the effort. For example, after testing several different breakfast menus, which seemed to have no effect on early awakening and were rather distasteful in some cases, he persevered because the elusive goal was worth pursuing.

Let's not forget that Roberts' self-experimentation did not occur in a vacuum. Friends, colleagues, and students provided anecdotes and suggestions that stimulated his self-experiments.

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His knowledge of various work in anthropology, and animal research concerning dietary conditioning, contributed to the birth of his ideas and the methodology for testing them. His university position, with tenure, provided support and a certain degree of liberty.

In conclusion, it seems worthwhile to distinguish two kinds of self-experiments in Roberts' article. First, there are self-experiments in which a person tries different treatments, and varies more or less systematically the conditions to observe potential effects. Second, there are naturally occurring self-experiments, such as the change of beverages in Paris. These natural experiments happen all of the time. Most people do not notice the potential information offered by these "experiments," which may be a result of "chance" events. Being in the self-experimental frame of mind helps one to notice, to analyze these natural experiments, and to make good use of them. As Pasteur once said, "chance favors the prepared mind." Is it possible that self-experimentation serves creative thinking, in particular, because it leads a person to see the world in terms of a particular project, and to pursue this project actively or passively over a long period of time?

Self-experimentation as science

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Abstract: Examination of the target article for its relevance to the analysis of private behavior leads to three concerns: the absence of a new methodology for studying private behavior, the undisclosed possibility of interactions, and insufficient attention to the social context of idea generation. Regardless of these concerns, a larger issue remains: Can a science of $n = 1$ be credible?

Kudos to *BBS* for publishing a target article at once offbeat and provocative, and to its author for estimable perseverance. His decade-long efforts to solve the personal problems of early awakening and weight loss are ingratiating as is his canny ability to invoke references to the Amish, astronauts, sushi, and tenure, for example, without once mentioning serendipity (except in his references).

It is not readily apparent how the target article should be classified. Is it evolutionary psychology? Applied psychology? Learning? Motivation? Or does it belong to the philosophy of science? Roberts' report drew me initially by its potential to illuminate a longstanding lacuna in the experimental analysis of behavior, namely, the analysis of covert (also termed "private") behavior. B. F. Skinner's recognition of overt and covert categories of behavior (and the further categories of respondent and operant behavior) placed them in functional relationships with the categories of overt and covert environments. Skinner averred that experimental analysis would ultimately reveal causal links between covert behavior and the overt environment. In that linkage, covert behavior and overt behavior were likely to be correlated at best, and not form the causal relationship that is intuitively appealing. The issue of how to access private behavior for the purpose of measurement and thereby functional analysis was left open and remains underexplored.

Self-experimentation of the sort Roberts exemplifies and extols is tantamount to a science of $n = 1$. The researcher and his (in this case) subject are the same person. Psychologists will recognize the precedent established by Ebbinghaus; Roberts cites others as well. Like Ebbinghaus' interest in improving his memory, Roberts' interest was personally practical. Whether Roberts' two-cycle model of mood or his Pavlovian model of the set point for body weight will match the canonical status of Ebbinghaus' model of serial memory remains to be seen. What drew my interest was his assertion that the models were evidence of the particular efficacy of self-experimentation for the generation of ideas. Having ideas is private behavior.

My reading of the target article as a contribution to the experimental analysis of private behavior produced three concerns. The first is that Roberts produced no methodological breakthroughs in measuring the private events that were his desire for sleep, his restedness, his mood, his hunger, et cetera. He also utilized the A-B-A reversal designs familiar to experimental analysts, though never formally stating the stability criterion he invoked in moving from one condition to the next. Still, the extraordinary longitude of his data-gathering and its meticulous detail inspire awe. Together with clever procedures for presenting lights and faces, for recording wakefulness, and for instituting a lifestyle dominated by standing, not to mention a stoical submissiveness to flavor-impaired fare, they may even constitute heroic achievement.

The second concern pertains to Roberts' apparent neglect of the possibilities for interaction between the consecutive phases of his research. This is surprising, given his admirable alertness to the possible confounds posed by expectation and his care in dismissing them. Though his experimental designs began with a baseline condition, there was never any chance to return to a condition sans the cumulative effects of earlier conditions. For example, is it possible that the striking effects of fructose water on appetite suppression and weight loss were, at least indirectly, due to the effects of his earlier dietary experiments or, more remotely, to the fact that much of the waking day was spent on his feet and that he was sleeping soundly?

The inherently social context of the generation of ideas is my final concern. Several of the author's examples begin with parenthetical reference to a friend's comment or to some other incidental observation. An idea follows that soon takes on a life of its own and predicates the ensuing experimental series. The fact that the author lives alone and can configure his home life as he will, seems a distinct boon to the success of his experimentation. His considerable freedom to style his professional life in ways conducive to the research lends further advantage. In my opinion, he has given too little attention to these factors. Nor does he adequately acknowledge his reliance on friends and other associates who can be assumed to share his interests and on whom he is reliant for nascent ideas – and, I suspect, for ongoing support and encouragement of his work, if only casually. It is also important to remember his reliance on the published work of other scientists whom he readily credits.

These concerns are not meant to fault the author's exuberance or the promise of the kind of science he represents. Instead, they point up the possibility that self-experimentation is more complicated and less solitary than it might appear. It may also be more insular. The author's confidence that what he discovered on his own about himself will generalize to others has three bases: shared biology, commonality of incidence and cause, and interspecific convergence. Whether generality will be achieved remains to be seen. The economy of scale that, for the author, underlies the potent efficiency of self-experimentation may also constrain its generality. Consistent with my concerns, the weight of nuance may ultimately prevent sucrose water from capturing the market from Atkins and others.

Should failure of generality detract from self-experimentation? Can there be a science of $n = 1$? If the research is resolutely performed in the interest of hypotheses, and painstakingly adheres to the conventions of design, analysis, and peer-review, can it be acceptable if its findings invariably apply only to the behavior of the single subject who happens to live within the same skin as the experimenter? Does that suffice as science? Or does science require that specific findings always be replicable in others? If so, can the credibility of self-experimentation as science consist in the generality of the method – that others will self-experiment with the same admirable fervor and rigor as Roberts and with comparably salutary results? Whatever the verdict, the author must be commended for carrying on in the spirit that Skinner (1976) celebrated in *Walden Two,* where the character named Rogers ex-

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