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Innovation Journalists, Null-Hypothesis and the Forgotten H0 Heroes

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Null hypothesis (H0) is not an inviting theme for innovation and science journalists. But when it is not adequately described, the logic of the innovation or science story can become weak and the readers cannot evaluate the theoretical importance and novelty of the reported findings. This invites them to entertain false beliefs of what is new, what scientists actually know, what they see as possible and what they think about the reported issue. In the social and human sciences this can introduce false beliefs about our identity and about us as human beings. Here we analyze the journalistic relevance of H0 and give examples of its use and misuse. Paradoxically, we argue that in the expanding information space, there is a significant increase in the intellectual value of the best theories that fail in their scientific predictions.

1 Introduction

Reporting on a theory that fails, or nothing new or surprising happening in a scientific experiment may sound like a turn-off to any science and innovation journalists, and even more so to their curious audience. But the language of innovation journalism becomes weak if it is detached from the best possible theories, even from those that fail. Imagine a piece of news before the birth of the theory of general relativity: "According to Newton's theory of gravity and the wave theory of light, a light beam should not bend in a gravitational field". Of course it should not, that was easy to believe at the time. However, when light rays from distant stars indeed were observed to bend in the sun's gravity field, it was news - not because of the observation itself, but because of the wrong prediction by the Newton's theories. One of the admired geniuses must have been wrong and it is not irrelevant which theory is wrong. This paved the way for the theory of relativity to enter the thinking of both laymen and scientists[1].

The case of Newton's theories of light and gravity shows why it can be so deliciously relevant to tell the story of the best possible theories that fail. But recognizing them is not an easy task to a journalist for the simple reason that together they carry all the relevant knowledge of how we have understood the world and what are the best alternative ways to think about it. To the reader, it is educational to know what they are and why they fail or succeed. In fact, most of us

[1] Newton did speculate that if light indeed has a mass, i.e. it is "corpusclar" in nature, then it should bend (Newton, 1704), but when it later became possible to measure the bending, his gravitation theory still gave an underestimated prediction.

entertain simply wrong theories about the world. In the present era of multidisciplinary science such relevant theories remain often hidden, forgotten or they are just nonexistent. Newton's theory of gravity (and that of light) was the best possible and imaginable basis for predictions in its field of science. But if even that theory failed to predict the outcome of a simple experiment, then something extraordinary and interesting must have happened. When a journalist manages to trigger scientifically well-founded expectations – even if they are wrong - in the readers' minds, it becomes possible to begin an intellectual and learning journey together with them.

However, if the journalist chooses a weak or an irrelevant theory as the source of theoretical predictions or does not write about the best theories at all then any novel research finding can be announced as scientific news. This is how the prophets of the paranormal and new age capture their reader's interest, by first directing their attention to a peculiar phenomena in nature and then by introducing explaining theories that actually do not allow the formulation of any testable hypotheses. During the times of information overflow, misinformation, and compulsory information search, the best possible theories gain new value. Paradoxically, we argue here that in the present information society, there will be a significant increase in the intellectual value of the best available theories, including those that fail in their predictions.

But do such ill-based and weak theories actually occur in science and innovation journalism? Here we show some examples of them and argue that often they remain as hidden anomalies of reporting that persuade readers to false expectations, misunderstandings of the knowledge in the field and illusions of the power of certain scientific methods to solve ambitious problems. In order to understand this fuzzy field of scientific predictions and hypothesis formation and its relationship to journalism, a short look at the null-hypothesis can be enlightening.

2 Hypothesis Formation and the Null-Hypothesis, H0

Scientists challenge existing theories by putting them at test in carefully selected conditions. They design experimental situations where it is possible to clearly formulate the predictions of the theory at test. For this purpose, they derive an implicit or explicit null-hypothesis from the old or prevailing theory to be tested – the "no-effect hypothesis", H0. It is given in the form of a prediction like "Variable Y will not be affected by variable X". When testing the Newtonian theories it could have read: Assuming that light has a wave nature, then " a light beam in a gravitational field should not be bent by the gravitational forces". The purpose of this statement is to logically represent the theory (wave nature of light, and the law of gravity) to be tested. If the results are against H0, the theory will be falsified, at least within the scope of H0 and the theory or theories behind it, and a new, alternative hypothesis H1 is supported. A new theory can now be suggested.

Often H0 is not stated explicitly, since the new findings can make it self-evident. But it does exist as an implicit prediction without which we really cannot discriminate significant findings from the insignificant ones.

When the bending of light was observed, the no-effect H0 was disproved, and an alternative theory was supported. However, testing a H0 is interesting only if H0 is theoretically relevant and based on the best theory available. If H0 is derived from a weak theory with no scientific status, or insight, then the finding of "a novel effect" has not much power either. Any finding can be novel and not been reported before, but it does not automatically make it scientifically valuable or even inspiring.

3 Hiding the H0 Makes any Novel Observation News

Some time ago it was reported by BBC (Learning languages 'boosts the brain', BBC October 13, 2004) that the scientists from University College London had found that "… learning other languages altered grey matter - the area of the brain which processes information - in the same way exercise builds muscles." In other words, learning foreign languages alters the brain, especially the cortex. Here the null-hypothesis remained unclear. However, it would have been educational to know and perhaps even more interesting than the findings themselves. Had it been written out, the readers might have learned how the knowledgeable scientists at the moment, and even before modern times, have thought about brain and language and what alternative ways there are to explain the role of brain in language learning. But because this was left unexplained in the news, the readers were silently offered an idea that *now* the structural basis of foreign language learning has been found – perhaps for the first time - in the brain. The eager ones and those less knowledgeable, could now think that it is not a long way until the mystery of brain and language learning will be solved. But this is a serious illusion.

Quite recently, it was reported in Science Daily as a breakthrough finding that "the runners' high" occurs in the brain ('Runners' High Demonstrated: Brain Imaging Shows Release Of Endorphins In Brain', Science Daily, March 6, 2008). What about H0 – a prediction that endorphins would not be released in the brain? Or perhaps something else could have been released in the brain and/or elsewhere? What could it be and what were the best theoretical guesses? The body of text in this news did not tell this although it was more comprehensive than the title and it indeed correctly told the logic of the study. But for a casual reader of the title, there was the message: "brain" + "imaging" + "endorphins" so that, clearly, "it's in the brain". The reader did not learn much what in this field of research is generally believed about this type of phenomena and the complexities involved. The top theme becomes the news. Less important is the view offered that it really is the endorphins, not just any other substance, or a combination and interaction of many potential substances or perhaps even several brain processes that underlie the

experience of "runners high". Because of a fuzzy H0, also the new, better theory remained obscure. Professionals, of course, must know better.

4 H0 on the Market

Brain scientists and physiologists are rapidly entering the field of market research, where it is surprisingly frequent to expect that "objective" brain recordings and other physiological measures can reveal what people as customers really think abut the products and how they perceive what is offered to them. Perhaps the most famous rumor and news (Taste challenge 'a state of mind', BBC 13 October, 2004) described the case of Coca-Cola vs. Pepsi studies where the scientists found that "Knowing the brand of soft drink can influence our perception of what it tastes like …". Furthermore, the article claimed, that "Brain scans showed when the volunteers knew which brand they were tasting, the parts of the brain involved with recalling memories were activated". An innocent question is in place: is there somewhere, in the scientific literature, or in the minds of educated people, a belief that the appearance of a drink or food, should not affect how it tastes. And that this might not be reflected in the brain activity? Is it really news that when people are confronted with a recognition task, it activates the brain areas related to memory function? One is left to wonder, what would be a creature that does not rely on any memory functions of the brain when it recognizes a brand?

There is a growing interest in the studies relating the brain activity to economics and decision-making. The experimental designs in these studies can appear complicated, while they still overlook the H0 and introduce false conceptions about the level of knowledge in the field. In an example study (Sanfey et al., 2003), the story was that "We scanned players as they responded to fair and unfair proposals. Unfair offers elicited activity in brain areas related to both emotion (anterior insula) and cognition (dorsolateral prefrontal cortex). Further, significantly heightened activity in anterior insula for rejected unfair offers suggests an important role for emotions in decision-making." When this observation is translated into simple everyday language it could read: "People react emotionally and cognitively to unfair offers. When people reject unfair offerings, they experience strong emotions". Does not sound quite surprising in this simple form, but the readers of this report are assumed to be enlightened of the finding that all this occurs in some specific brain areas. The reader is actually persuaded to believe that it is a simple matter to tell what brain areas are related to cognition and what are related to emotion. This is simply misinformation. Of course one may argue that the study offers information about where in the brain this takes place, but any physiologists can tell that the anatomical resolution in this news is like telling that we use the knees and ankles in running and walking.

5 The Infinite Frontier of Brain News: God on the Brain

A report from BBC was titled “God on the brain” (BBC February, 2005). It described how two epileptic patients had religious hallucinations, and how “Research into why people like Rudi and Gwen saw what they did has opened up a whole field of brain science: neurotheology’” While this might be interesting, it remains even more interesting what was the null hypothesis that the scientists had in mind and why should a new science be needed? Is there, somewhere, a known and documented scientific belief that no brain activity would be expected in the brains of people who are experiencing religious thoughts? Why should a religious feeling or experience be somehow different from other mental phenomena? Readers were led to believe so, because no reference was made to the best available brain theories related to this specific problem. This type of a hidden anomaly allowed – and even encouraged - the readers themselves to formulate any H0 hypothesis, perhaps something like “during religious experiences, no activity should be found in the brain since the phenomenon itself is spiritual”. When brain activity was indeed found, it was news. Based on observations of the discussions in the net, some readers might have thought that now the *cause* for religious thoughts has been found. Because of the lack of explicit H0 in the report, the news might even encourage some readers to think that it is the religious people who really entertain a belief that the brain has nothing to do with their religious thoughts and activities and that now they should know better. This has not been directly said in the report, but the internet discussions tell how it was interpreted. The richness of the deepest mental and spiritual phenomena and processes that underlie the complex aspects of the human nature and culture, were simply pushed aside.

6 Hidden H0 Shapes our Identities

Often the news texts take it for granted, that an observed average difference between, say, two groups is a sign of a general phenomenon. In such cases, the underlying H0 prediction is that there should be “no average difference in a measured property between the experimental group (the one being treated or possessing a specific factor such as a gene or an income level) and the reference group (the one *without* a treatment or without a certain relevant factor such as a gene, social class, income level etc). As an example, when a specific group (e.g. a gene possessing group) under study deviates – in some measureable property like personality - statistically significantly from the reference group (the no-gene group), the finding can persuade the readers to think that the gene has caused the difference. Although most gene scientists agree on that we do not know how the personal genome affects the lives of most people, there is a flood of studies linking genes to our illnesses, personality, and other individual characteristics. Give "genes and personality" to Google and you can get approximately 900 000 hits while “genes and illness” gives hits about third of that. But are all people similar in how their genes guide their lives and are these findings valid in Africa, South America,

or distant parts of Asia as the well-known gene researcher, professor Leena Peltonen-Palotie once asked in a public debate at Washington University?

7 The Case of Novelty Seeking and the Hidden H0 Heroes

A study by Richard P. Ebstein and his colleagues received great attention in numerous laboratories and news channels when it demonstrated that individuals who possess a certain gene, have on average, a higher probability to novelty seeking behavior than those that do not have the gene (Ebstein et al., 1996). Interestingly, in this remarkable study as in most similarly designed comparative studies, the data itself includes individuals, often quite many of them, who have the gene, but do not have the predicted characteristics. In this case these "deviants" did not have the novelty seeking personality. In other words, their personalities were just as predicted by H0 – no effect. A journalist may want to imply and tell the audience that the average finding suggests the existence of a general phenomenon, but perhaps then he should be even more critical with the confidence limits than the scientists who just look for significant differences between distributions?

How should we treat the data of these "deviant" individuals, the *H0 heroes*? Indeed, in this and many similar cases they deserve the title, since they do not show the behavior that would be expected on the basis of the group averages. They are the proof that the observed average phenomenon is not a general one. Should their data also be reported? Who should report it and how? Is such a deviance a significant finding? Is it just statistical noise that can be neglected, and if so, what kind of noise is it and why did it occur in the material? Was it studied carefully and explained? What does the deviant data tell to the scientists and to the audience? Could we learn something of how different we actually are as human beings?

When these studies became news, the focus of discussion was on the possibility that now the underlying mechanisms of novelty seeking behavior were being discovered. Further evidence and criticism followed, but an invitation to new thinking about us as individuals was offered to the interested audience. As a follow-up, it was reported that it is in the brain, i.e. we have a "risk-taking brain" (Personality genes. Evidence of 'risk-taking' brain: Scientists say they have found physical evidence of brain differences which may drive "thrill-seekers" to act impulsively or dangerously, Time 27 April 1998).

How to deal with these unwelcomed H0 heroes? They appear to have very little news value, if any, but they should. It is a significant finding that genes can have different effects on individuals. Recent news on epigenetics indeed confirms this: there is a complex interaction between the biological environment and the genome. It is relevant, and even a basic right, of the general audience to know, that causality in these cases is a very complex issue. It is valuable for us as human beings to think in an intelligent way about each other. The reporting in these and similar cases has far-reaching consequences, because it teaches the audience what to think about the differences between people and about possible general phenomena. This

emphasizes the value of such authors like Malcom Gladwell who presents a celebration of individual differences in his book Outliers: the story of success.

Reporting without H0 guides us to the naïve belief of biological determinism and that the genetic findings are the first signs supporting this. But if H0 heroes are not cast aside, we can learn that, perhaps, we are inherently different and that explaining the nature of these individual, cultural, and environmental differences remains a very complex scientific challenge. Scientists and journalists take the power to shape our identities by teaching us what science has to say about the human nature.

8 H0 Heroes Among Us

The results of the famous Milgram experiments (cf. Milgram, 1974) showed how people could be persuaded to conduct inhumane acts. However, it is less well known that not all of the subjects simply obeyed, and that some them refused, even under the extreme social pressure, and probably a majority of test subjects showed emotional distress. What would we gain by reporting the H0 heroes, who refuse in such situations? We would learn, that in extremely difficult situations, there are, among us, people who are ready to resist what they see as unfair, unjust, and wrong. We would learn, that our identities vary and that our behavior is not guided by group averages. We would learn, that even in threatening situations, it is possible that we are not alone and that some of us are strong enough to resist any social pressure. In some cases it pays to know this and when data so indicates, it is not only important but also ethically imperative to tell this to the reading audience. It will shape our assumptions about us and other human beings.

9 Discussion

Scientific findings and innovations represent a breakthrough of something new but also an intelligent step out of the old. Reporting innovations opens a window to an unknown world, creates a new language to negotiate it, and offers platforms for further discussions and thinking. The news value of innovations is not only what is novel about them, but also what they leave behind: present conventions, habits, paradigms, common sense and the best possible theories of the world. Clever and intelligent theories support the discovery innovations, when they are right but also when they are wrong.

A key role of innovation journalism is to facilitate and critically evaluate those creative processes that produce new and valuable knowledge, solutions and innovations. There is always the risk to support the dominating and trendy players and findings, and forgetting the critical look at innovation and science reporting. As strange as it may seem, the analysis of null-hypotheses helps to ascertain that innovation reports and news are grounded in best available knowledge in the field. Of course it should be in the interests of the innovators to disclose, in a humble and

truthful way, the actual background of their work, but this is a hard demand for them in the fight for a visible place on the competitive forums of science and innovation. For journalists it is necessary to see when this has been done and especially when it is not the case.

10 Why Should Innovation Journalists be Interested in H0 Heroes?

We can be led to believe that as individuals, we are not different from masses and that by looking at mass phenomena we learn essential aspects of individuals and individual life. For example, general intelligence is widely assumed to determine our intellectual life and career. It may well be so, but in most cases the data suggests complexities and individual variability that should be explained as well. One may think that in building scientific theories it is necessary to look at gross phenomena. But the situation is different when the scientific data becomes reported to the general audience who will be educated by it, and will adopt the news of the findings *and* the underlying assumptions behind them. Science news will teach people how to think about themselves and about other people.

By hiding the null-hypothesis and ignoring the H0 heroes in any study of the human nature and behavior we are taught that it does not matter at all, that some of us, often quite many, do not behave according to the statistical averages, models or theories suggested. They can become implicitly and even explicitly treated as noise in the measurement system. Although the perspective in the present paper is dominated by the topics of the brain, behavioral and social sciences, this message is not irrelevant to natural sciences either. Brain sciences and genetics are, indeed, most fascinating areas of today's science, and they will continue to feed their knowledge and assumptions about the human nature to the general audience and to the scientists of other fields. Too often, the H0 heroes remain as scientific outlaws in the discourse because they are the proof of the complexity of the research issue. But they are a gold mine for critical innovation journalists.

11 Multi-Disciplinary Challenges

Multidisciplinary research and innovations have become demanding to follow, and difficult to both scientists and journalists to master. There is an emerging need for an intellectual ownership of the multidisciplinary hypothesis formation. This ownership is declared by the knowledge of the best multi-disciplinary theories in the field, understanding of their significance and relevance for scientific knowledge building. Gene research is a perfect example where it is necessary to combine the knowledge of genetics and gene technologies, with many forms of human social or health science. It is simply too much for any individual to fully master, but it can be covered by multi-disciplinary collaboration - also among the journalists.

Innovation journalists face the task to mediate this complex knowledge to different audiences, from specialists to the general public in a way that secures the availability of the best theoretical background and accumulation of knowledge as well. Lack of H0 or vague description of background theories makes it difficult to evaluate the claimed new findings. This entertains misguided beliefs of the significance of the findings, creates unrealistic expectations, and opens channels to the manipulation of the reading audience. Simply stupid theories can be entertained under the multi-disciplinary umbrella.

The future of Google and its followers, semantic search engines, open source models, and the availability of nearly any level of knowledge to special and general audiences changes the knowledge environment of innovation processes. At the same time, we see the birth of within-science journalistic and pr-thinking that aims at success and survival in the competition by using the available communication channels. The role of science and innovation journalists will be to live up to that development and to represent a force that can look behind these motives. The quality of innovation journalism will determine the quality of the intellectual infrastructure where new knowledge is diffused to the society.

12 H0 Heroes Populate Today's Studies

One may think that the topic of H0 hypothesis is mostly rhetoric in nature. A quick look at some recent science and innovation news from week 18/2010 shows that it is not. Take a look at the list of science and innovation news titles: Genetics and Post-traumatic stress disorder (Science News, May 3, 2010); Even silent videos excite the listening brain (New Scientist, May 8, 2010); Charting creativity (in the brain), The New York Times, May 7, 2010); Kids overimitate adults regardless of culture (Science May 7, 2010). Common to these news reports is their way to generalize, show a weak analysis of H0 and alternative explanations, and to skip the analysis of H0 heroes. But they are inviting reading, and they have an attitude to teach the audience. For example, the readers learn the unspoken assumptions that: it has been thought that the brain behaves as a simple one channel system for each sensory system (this has not been true over the history of brain sciences), creativity is a well-defined phenomenon in the brain (it is a very wicked problem), children imitate adults without thinking (they always think of the context).

Nearly 200 years ago the phrenologists read the personality of a subject from the bumps on his skull, and even today astrologists predict our future and destiny. Fortunately, it is easy for anyone to find out, even in our own lives, if these predictions are true or false, but today, we cannot, as individuals, really verify or falsify the predictions or generalizations based on the findings concerning, for example, the average brain and the average presence of a gene. Scientists and innovators cannot put a stop to the increasing flow of misinformation, false beliefs, and expectations, but innovation journalists can share the inspiring and ethical task to do so. Paradoxically, in many cases the best way to do this, is to carefully look at the best possible theories that fail.

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13 References

Charting creativity (in the brain), The New York Times, May 7, 2010

Ebstein, R.P. Novick, O Umansky, R. Priel, B. Osher, Y. Blaine, D Bennett, E.R. Nemanov, L. Katz, M. & Belmaker, R. H. (1996) Dopamine D4 receptor (DRD4) exon III polymorphism associated with the human trait of novelty seeking. Nat Genet 12, pp. 78–80.

Even silent videos excite the listening brain, New Scientist, May 8, 2010

Genetics and PTSD (Post-traumatic stress disorder), Science News, May 3, 2010

Gladwell, M. (2008) Outliers: the story of success. Little, Brown and Company

God on the Brain - programme summary, BBC, February 2005, http://www.bbc.co.uk/science/horizon/2003/godonbrain.shtml

Kids overimitate Adults regardless of culture, Science May 7, 2010

Learning languages 'boosts brain' BBC News, Wednesday, 13 October, 2004, http://news.bbc.co.uk/1/hi/health/3739690.stm

Milgram, S. (1974) Obedience to Authority: An Experimental View. New York, Harper and Row

Newton (1704) The First Book of Optics, part I.

Personality genes. Evidence of 'risk-taking' brain: Scientists say they have found physical evidence of brain differences which may drive "thrill-seekers" to act impulsively or dangerously, Time 27 April 1998, http://news.bbc.co.uk/1/hi/health/7802751.stm

Runners' High Demonstrated: Brain Imaging Shows Release Of Endorphins In Brain., Science Daily, March 2008, http://www.sciencedaily.com/releases/2008/03/080303101110.htm

Sanfey, A. G. Rilling, J. K. Aronson, J. A. Nystrom,L. E. & Cohen, J. D. (203) The Neural Basis of Economic Decision-Making in the Ultimatum Game Science 13 June 2003: Vol. 300. no. 5626, pp. 1755 – 1758

Special panel discussion: The Personal Genome: Consequences for Society, discussion at Washington University, April 23, 2008

Taste challenge 'a state of mind' BBC News 13 October, 2004 http://news.bbc.co.uk/1/hi/health/3739462.stm