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Nobel Strengths: The Attributes of Scientists by CAVE

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Keywords
CAVE, attribution, attributional, explanatory, optimism, pessimism, precocity, longevity, creativity, scientists, achievement

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Introduction

As Yuasa (1974) foresaw for science overall, the state of chemistry in the U.S. is in decline in terms of papers published, citations, and students seeking PhDs in chemistry. Still, the country has strengths including "instinct to respond to external challenges, to encourage innovation and to compete for leadership" (National Research Council, 2007, pp. 4-5). The study reported here seeks with its results and analysis to help scientists in both chemistry and psychology, if not in general, understand how to encourage scientific innovation mainly from a positive emotion standpoint. It aims to reveal any quantitative and qualitative relationships between the level of optimism revealed in explanatory styles, the consequent likely positive connection with positive emotion, creativity, and research output of eminent scientists.

"What I especially love ... is this intimate alliance — which for me makes the true man — of pessimism of the intelligence, which penetrates every illusion, and optimism of the will." (Rolland, 1920; as quoted by Fisher, 1988).

Literature Review

Fredrickson and Losada (2005) found that about a three-to-one ratio of positive to negative emotions helps broaden and build a work team's perceived array of options, as in finding solutions to problems or generating ideas by brainstorming. Research scientists especially seek novel solutions and opportunities as a basic part of their work, so it stands to reason that fostering positive emotions among scientists would likely enhance their creativity. Nobel laureates then – being highly creative – ought to or may show evidence of about three times more positive emotions than negative emotions, as perhaps reflected in their attributional statements about their achievements.

Ghiselin (1952) compiled self-reports in the form of essays by highly creative mathematicians, artists, and scientists, like Poincaré, Mozart and Einstein. The essays and Ghiselin's commentary reveal at least a few clues for designing an empirical psychology study on the cognitive and emotional processes behind creativity. Poincaré for example wrote "Invention is discernment, choice", which may be the second overall, cognitive step in the invention process, where the first is broaden and build. While positive emotion is essential to take a broad view towards disparate ideas, the inventor is also the examiner "in the second degree" who discerns the ideas that may be interesting, feasible and useful (1915). Regardless of whether the person is an artist or engineer, that person must be adept in the field of endeavor - mindful and intelligent to have a good chance of producing something new that is also useful.

Nisbett and Wilson (1977) found that people are generally quite poor (though they may try hard) at describing their cognitive processes, which then raises the challenge to try to understand how top scientists might describe how they develop ideas. Part of the impetus for the investigation reported here is to see if explanatory style might be a useful way to shed more light on how emotional-cognitive-creative processes work in highly accomplished people like Nobel Prize winning scientists.

Explanatory style may be a means to reveal at least how emotions, if not cognition, bear on creativity. President Johnson was more decisive and less passive as his explanatory style became more optimistic, which arguably is important for effective leadership, in politics and in general, including then R&D (Zullow, Oettingen, Peterson, & Seligman, 1988). Scientific research, like politics, entails significant risk predicated on the assumption that most ideas that come to mind, even those of well-educated, gifted scientists do not work. The heuristic is that most ideas prove in the end to be neither interesting nor consistent with what is known. Continued pursuit of such ideas would then be a mistake. Yet, a researcher who is generally pessimistic may not only be passive, but also risk-averse and unwilling to try new, risky approaches. A risk-averse scientist, like some leaders as well, would also be more apt to treat mistakes as potential threats and cover them up, instead of welcoming them as possible learning experiences (Sternberg, 2002; Pezzo, & Pezzo, 2007). Of concern however is President Johnson's occasional bold, near manic behavior when he was subsequently and predictably very decisive, which might also suggest at least transient behavior consistent with a "Type A", precocious person (Friedman, & Rosenman, 1959; Edwards, Baglioni, & Cooper, 1990). Type A people tend to show ambition, competitiveness, time urgency, but also impatience and aggressiveness. Though some of that behavior may at times be an asset for scientists, impetuousness probably is not, given the physical dangers that lurk in most labs and the high cost of wasting resources on foolish ventures. Instead, scientists would seem better served with a healthy combination of optimism, skepticism, even context-specific pessimism or prudence: A trait of advantage to law students and probably physicians as well (Satterfield, Monahan, & Seligman, 1997).

Presidential candidates who showed more pessimistic explanatory styles for negative events in their convention speeches could be predicted to 90% certainty of losing the subsequent election (Zullow, Oettingen, Peterson, & Seligman, 1988). Among the arguments the authors offered: The ruminative-pessimistic candidate was less attractive to voters. Unclear was whether candidates who conversely might show optimistic explanatory styles might be more likely to win elections. Intuition thus informed might nonetheless lead to the expectation that the more optimistic scientist is more likely to be attractive to work for as a student, so such scientists ought to have significantly more graduate students at the lab bench and eager collaborators in general. There may however be a confounding variable: Independent of the psychological orientation of the leading scientist, the nature of that person's research work itself may be attractive to young, ambitious scientists, which may be a bit tricky to account for.

Investors may be well-advised to investigate companies whose leaders show healthy explanatory styles similar to those of successful presidential candidates. Corporate annual reports that offered internal attributions for negative events, but that were otherwise characterized as unstable and controllable, would be likely to see their company performance and stock price increase in the year following the negative events (Lee, Tiedens, & Peterson, 2004). The explanation offered was that such an explanatory style showed a higher sense of responsibility and accountability for negative events, which in turn lead to more shareholder confidence in the company leadership. Explanatory style then does not necessarily have to be consistently optimistic for the outcomes to be positive – to the contrary – in some contexts and in some dimensions a pessimistic explanatory style may be an advantage and an asset.

Such was also evident in law students' academic performance, which tended to show a positive relationship with pessimistic attributions for negative events (Satterfield, Monahan, & Seligman, 1997). Just as healthy skepticism or "defensive pessimism" (p. 103) would lead an otherwise proficient law student to attribute a poor grade on an exam to a failure to consider all possible contingencies in the essay questions, so would such traits keep a scientist from jumping to fanciful conclusions in the face of unexpected results (Satterfield, Monahan, & Seligman, 1997). Not only would that be prudent, but responsible as well. Being prudent would likely have a strong association with awareness, mindfulness and humility, in the sense of the person having accurate self-knowledge, particularly about strengths and limitations (Peterson, 2006). Eminent scientists may then express perspective and humility in their causal attributions for both negative and positive events. With their strong intellectual abilities, Nobel laureates would likely still convey a sense of competence about influencing, but not necessarily completely controlling events.

Explanatory style for negative events is generally stable over a lifespan while for positive events it is unstable, which then ought to be a consideration if not concern for the study reported here (Burns & Seligman, 1989; Peterson, Seligman, & Vaillant, 1988). A pessimistic explanatory style is a strong predictor for depression, low achievement and poor health. Given on the other hand the expectation that Nobel laureates are generally optimistic in their attributions (still unstable but perhaps more stable than the population in general), then they ought to show not only high achievement, but generally better well-being and health than the general population. Some however may be precocious, Type A personalities, with strong ego attachment to their achievements.

McCann (2001) argued for the precocity-longevity hypothesis: Eminent individuals who reach their peaks early in life are more likely to die early if they are Type A personalities and consequently prone to the ailments associated with Type A, like hypertension, poor diet, unhealthy lifestyle, etc. This raises the question: Are Nobel laureates more often Type A or B personalities, and how might that show up both in their life histories as well as in their explanatory styles? McCann's focus was on the precocious eminent individuals, while in the present study the view is broader, focused still on exceptional chemists of course, but both the precocious and non-precocious, Type A and Type B personalities.

Simonton (1988) noted that there is near concensus among social scientists on broader facts, namely: (a) the positive association between precocity, productivity rate and longevity; (b) the sharp increase in productivity in the early years and slow decline after a peak around age 40; (c) the curve varies across disciplines. Simonton's argument for further research, which after broad interpretation from the context of this study, suggests investigation of how achievement, health and longevity might be connected and extended. The results of such work may consequently help mitigate the concerns Yuasa expressed over thirty years ago about the probable onset of decline in U.S. science around year 2000 when the average age of scientists was about 50 (1974).

Research Problem Statement

Are Nobel laureates psychologically atypical of scientists in general and if so, how? Stipulating and controlling for the likelihood that they are exceptionally creative and intelligent, are Nobel laureates then also exceptional in their emotional responses to both negative and positive events in their scientific work? Would any such exceptional characteristics show up in their banquet speeches in which they might describe causes for negative as well as positive events?

Scientific research may be like the legal profession in some salient aspects, particularly in offering implicit reward to those with attention to detail, who take into account as many contingencies as possible. Such characteristics may be the forté perhaps of the pessimist, even the Type A personality. Especially the high-achieving scientists who win the Nobel Prize at a young age may be highly-driven, precocious people who tend to die young, or at least whose subjective well-being may be under strain. The results of this study may then reveal instead a pessimistic explanatory style for some specific types of events in particular contexts, like when scientists interpret results, particularly for those Nobel laureates who make their most recognized achievements when they are still young.

On the other hand, their explanatory styles may show that the highest achieving scientists have an exceptionally optimistic approach to their research work, despite – even *because* of - its demand for an eye for detail and contingencies. Such scientists may instead tend to be the archetypal Type B personalities, who are more apt to live longer, healthier lives during which they continue to make significant accomplishments even after winning the Nobel Prize.

The problem under investigation is whether Nobel laureates' explanatory styles found in their banquet speeches will reveal them to be significantly more optimistic perhaps than scientists overall, and if so, in which particular ways and contexts might they be more optimistic.

Hypotheses

Nobel laureates in the physical sciences clearly show a high level of achievement (at least before winning the Nobel Prize), which in some cases may stem from their having high precocity, perhaps Type A personalities. Under the favored hypothesis here however, such Type As are in the minority among Nobel laureates, who instead are more frequently Type Bs who tend to show high humility (accurate self-knowledge), which likely connects with mindfulness about their work, their lives and other people with whom they work. These characteristics or strengths ought to be evident in much of the Nobel laureates' explanatory styles as revealed in the analysis of their Nobel banquet speeches.

A strong assumption would be that Nobel laureates are very intelligent, cognitively-oriented, creative people - less clear may be their emotional orientation. The hypothesis here goes on to suggest that laureates have a strong emotional affinity for engagement and meaning in their lives, which also ought to be reflected in their explanatory styles. Sense of perspective is likely to be a key characteristic that may connect to the results. Type B laureates would then probably strike a healthy balance between the extremes, as with their attributions being neither entirely external nor internal.

As in work with other populations like high achieving athletes (Martin-Krumm, Sarrazin, Peterson, & Famose, 2003), especially optimistic people – Nobel laureates perhaps as well – are more apt to attribute positive events to internal characteristics, and more apt to assign external causes to negative events; but not extremely so, which is a salient characteristic of resilient people (Rettew, & Reivich, 1995). Also at issue is whether high achieving scientists may be somewhat like law students where the more pessimistic ones outperformed those who were more optimistic (Satterfield, Monahan, & Seligman, 1997). Science – like the law – arguably encourages a skeptical outlook that takes into account myriad contingencies that may as well correlate with a pessimistic cognitive-emotional framework of thought. Nonetheless, the hypothesis expects a lack of extremes to be a characteristic in the explanatory styles of Nobel laureates … except perhaps in cases of Type A personalities, who ought to show larger swings on at least some of the dimensions. Though the larger population of scientists may have a more pessimistic frame of thinking, Nobel laureates may be the optimistic exception.

The main focus of this study is chemistry and what its Nobel laureates may reveal through their causal attributions about how the field is faring lately in comparison to other disciplines. Given the results of the National Research Council 2007 report on U.S. chemistry, one hypothesis here expects that recent chemistry Nobel laureates may be somewhat less optimistic about their field as compared to physiology or medicine.

In summary, the other hypotheses are:

1) Nobel laureates are more often Type B than Type A personalities, with possibly some notable, precocious exceptions.
2) They have generally optimistic explanatory styles; however, they will show signs of healthy skepticism that

may be taken as somewhat pessimistic explanatory styles, depending on the specific events they may describe.

3) As a further consequence of Nobel laureates being predominantly Type B optimists, they are overall healthier than scientists in general and the population as a whole.

The hypotheses then do not expect:

1) Most Nobel laureates are precocious Type A personalities.
2) While they have generally optimistic explanatory styles, which accounts for their high creativity, they also show large swings towards occasional pessimism depending on context. They tend to show high internal attributions for both positive and negative events with accompanying high controllability.
3) They reach their peaks early in life, on average, and have poorer health and longevity than both their less eminent science colleagues and the population at large.

Content Analysis of Verbatim Explanations (CAVE)

CAVE is a two-stage linguistic analysis process (Lee, Peterson, & Tiedens, 2004; Zullow, Oettingen, Peterson, & Seligman, 1988). In the first stage coders, preferably blind to the hypotheses of the study, extract causal attributions in transcripts of verbal content, such as speeches or press conferences. Coders determine whether a statement is a causal explanation based on criteria, like those David Hume articulated (cited by Becker, 2001): The cause offered needs to have a contiguity, precedence and constancy relationship with the event. The explanations extracted next go onto a scoring sheet for the second stage coders, also blind to the hypotheses, who rate the statements on five dimensions: negativity, internality, controllability, globality and stability, typically using either a seven- or nine-level Likert rating scale. An event the speaker expresses as being welcome would deserve a low negativity rating. A cause for an event that the speaker expresses as existing mostly within that person would likely get a high internality rating, for example. There is much evidence to show that the kinds of people who are at risk for depression, poor health and low achievement strongly attribute negative events to internal causes that they believe they cannot control, that affect many aspects of the person's life, i.e. global and that are very stable (Peterson & Seligman, 1987). Optimists on the other hand tend to attribute negative events more to external causes and see them as more controllable, local and unstable. The focus of this study, however, is somewhat more the positive events.

Procedure

The principal investigator (PI) downloaded the Nobel laureates' in chemistry, physics and physiology or medicine banquet speeches from the nobelprize.org website. He then removed names of the speakers and any obvious identifying information before printing out the transcripts for the first stage coders to extract the attributional statements. Some speech transcripts included remarks of a representative of the Swedish Royal Academy of Sciences for example, which the PI removed; however, if a transcript also had remarks of the laureate to students that portion remained for the coders to examine.

First stage coders first read instructions (cf. the appendix) the PI wrote on how to identify attributional statements before getting underway with their work. Extraction either took place in supervised, two-hour classroom sessions or at the coders' homes where they marked the printed transcripts with a highlighter that which they judged to qualify as statements of causation. The PI then transcribed the marked statements to a rating form for the second stage. The PI excluded any statements the coders indicated as attributional if they clearly did not meet the cause-event criteria as described in the instructions.

Coders in the second stage rated the attributional statements on seven-point Likert-type scales, one each for the dimensions with labels: *negativity*, *controllability*, *globality*, *internality* and *stability*. The PI as part of the written and verbal instructions provided coders with definitions and likely unambiguous examples (from business CEO speech verbatim transcripts) of attributional statements with strongly different ratings on each of the dimensions. The statements extracted from the Nobel speech transcripts would not necessarily in all cases be as extreme in their ratings as for the example statements from the corporate speeches.

A concern for biasing the coders was pervasive in the approach to the procedure. Prospective coders were blinded on the hypotheses under investigation, so the announcement seeking assistants did not make mention even of CAVing to try to reduce the possibility that a person would find papers on the method. The PI used care in preparing the instructions to avoid revealing the study’s hypotheses and thought of the process somewhat like how judges may instruct juries in a trial, to lay down the ground rules without giving opinions about quality of factual matters.

A pilot coder tested the extraction phase of the coding as to the clarity and usefulness of the instructions, which the PI revised before the first stage got underway. The pilot stage revealed complications that would result from coders doing pre-coding homework, in which they might consult in-home reference materials for definitions of terms like *attributional statement*. A basic assumption was that the potential for bias, divergent or mistaken understanding would be minimal if coders all worked off the same set of instructions with little outside influence, (except of course for the unavoidable influence of an individual's education).

The person undertaking the pilot stage prior to the first phase coding was a retired professional German language translator. The first stage coders consisted of an undergraduate student in English and a retired high school English teacher. The second stage coder was a graduate student in linguistics.

Speeches in languages other than English did not get translated because professional translators were not available at a rate that the study's budget would allow. Some of the more recent speeches on the nobelprize.org website were already professionally translated into English, so a cultural influence on the results would seem at least a possibility.

Results and Discussion

Among the hypotheses, one suggested the possibility that the chemistry Nobel Prize winners' explanatory styles may have been significantly different from those of laureates in other physical sciences disciplines, so the chemistry attributional ratings were first compared to a sampling from the physiology or medicine group. Table 1 shows the average ratings for both groups and the ANOVA results to determine the significance of any differences between them. The two groups were not significantly different on any of the five dimensions, so their scores were subsequently combined to produce the results in table 2.

The Nobel laureates in chemistry and physiology or medicine gave strong evidence of having optimistic explanatory styles with sense of perspective. The average negativity rating was 2.31 with standard deviation 1.40. Among 120 total attributional statements, 103 had negativity ratings less than 4 (positive statements), just 14 had ratings greater than 4 (negative statements), and 3 were rated 4 (neutral). More surprising and striking was the high globality average rating of 6.19, standard deviation 1.02. The Nobel scientists seemed to describe the many positive events as having impact in many, widespread domains. Very optimistic indeed, but not necessarily ebullient.

Unlike the authors of corporate annual reports, the Nobel laureates showed much less of a self-serving attributional bias for positive events. The laureates had a comparatively low controllability rating of 3.21 (standard deviation 1.42) and internality rating of 4.42 (standard deviation 1.75) for positive events, as compared to a controllability of 2.71 and internality of 4.36 for negative events. Though the scientists showed the expected, positive intercorrelation between internality and controllability, the association was not nearly as strong as that for the corporate attributional statements. Other intercorrelations were weaker still and even tended in the opposite direction from those for the corporate attributional statements. While the annual reports indicated a somewhat firm belief in the company's control over local, internal positive events, the Nobel scientists showed much less belief in their having control over positive internal events, irrespective of their globality. Yet, like the corporations, the Nobel laureates saw negative events as somewhat more stable than positive ones.

Generally, the results of this study would be consistent with the Nobel group being slight depressives, *had it not been* for their very low negativity scores. This shows how much the score in one dimension can change the interpretation of the results on all dimensions. While a probable-to-lose presidential candidate might get a high pessimism-rumination score on negative events, a typical Nobel winning scientist might get a high optimism-contemplation score on positive events.

The explanatory styles of eminent scientists may be consistent with their view of science as descriptive instead of prescriptive, where the latter has a connotation of scientist in control of events, while the former is more consistent with the scientist as explorer and mindful observer.

A few typical statements may serve to illustrate and bring more life to the numbers. Table 4 shows such typical statements, chosen as examples if all their ratings came well within a standard deviation of the overall average ratings. Table 5 shows the atypical, negative statements, which will get discussion below in the section on study limitations.

Unexpected may seem the high stability ratings for the statements with the words, “chance observation” and “fortune, fate or destiny”; however, an interpretation may be that the scientists see chance paradoxically as a constant, pervasive aspect of their work. This may then be consistent with both the high globality and low controllability ratings.

Study Limitations

Before going further with such more elaborate, even paradoxical interpretations of the results, the ordinary alternative explanations need consideration. One perhaps less interesting interpretation may be that the results are a measure not necessarily always of the Nobel laureates’ attributions, but of the rater’s opinions and worldview. Previous CAVE studies showed high inter-rater reliability, so presumably if this study had more raters that would be the case as well. The rater for this study is a graduate student in linguistics, which may have both advantages and disadvantages: On one hand she would likely have a well-trained eye for the nuances of language, but may be apt to infer more than what the speaker may have intended and thus overlay her views on top of those of the speakers. With this concern in mind, the principal investigator chose a sample of statements that would serve as exceptions, attributions for negative events, that may allay concern about rater bias and still leave open the more interesting interpretation of the results overall.

The very pessimistic statement about homo sapiens catastrophic wiping out other species, pessimistic especially for its high negativity and low controllability ratings, might be an example to show rater objectivity; (see Table 5 in Appendix). A rater could disagree with the statement and contend that our species has more control over the fate of other species, but the statement viewed objectively indeed does not convey a sense of homo sapien's perception of control over mass extinctions.

Social desirability would seem a likely factor in producing positive bias for externality. Expectations to show expressions of gratitude make the banquet speaker more predisposed to make external attributions as to the causes for receiving the Nobel. Bias may get further amplification by some speakers referring to previous speeches, which would likely reinforce social desirability, not to mention the general cultural practice of giving thanks at an occasion such as a white tie banquet. That said, social desirability thus seems a factor that one can account for; still its effect would underscore the need to take context into account.

With a few Laureates at least there may be some exceptions, however. Einstein's biographer Walter Isaacson (2007) describes him as a non-conformist for example, who consequently may not be as inhibited to speak his mind, even at a Nobel Prize banquet with royalty present. (Einstein's speech did not get analyzed in this study because it was in German.)

The Nobel Prize is very likely not a popularity contest, at least in the physical sciences. The Royal Swedish Academy of Sciences chooses winners based on their work, its originality and significance - the laureates' personalities ought to not weigh in to the selection criteria.

The effect of social desirability may be different in political or corporate speech, as perhaps indicated by differences in self-referential word use, as use of the "royal we" might show (Pennebaker, Slatcher, & Chung, 2005). A political speech may be more self-serving compared to a banquet speech to give thanks and acknowledge others who helped with a research project – Nobel winners would arguably be more sincere in their expressions of gratitude because they are not in a campaign for votes. Though social desirability is likely to bias results towards the positive, it is also unlikely to do so in a uniformly strong way; some speakers will use the opportunity to express their view on the state of their fields of endeavor, even the world, because as intelligent people speaking to others whom they respect, they will be diplomatic, but frank in sharing their views, even with warnings about mass extinctions. Thus, the results will not be purely a reflection of social desirability and the laureates being uncharacteristically positive simply because of the elegant ceremony and presence of royalty.

Summary of Results and Conclusions

Absent from the results for Nobel laureates' causal attributions were indications of precocity and Type A personalities, which would suggest that precocious Nobel Prize winners are in the minority, with their possibly divergent explanatory styles consequently having minimal impact on the averaged results. Laureates' longevity, health and vitality appear to be better than average. Of the 82 chemists awarded the Nobel Prize between 1901 and 1972, the average age at death was 76.1 years, 90.2% were married, and 84.2% had children; 32 had three or more children. Most continued to produce significant research results well after being awarded the Nobel; still, their long-term well-being and level of achievement deserve much further in-depth examination. The overall results reported here would appear more consistent with Type B personalities who have less ego attachment to the results they produce, as indicated in the lower scores for controllability and internality over positive events than the results showed in the corporate world, for example.

Juxtaposition of very low negativity and high globality with moderate internality, controllability and stability might arguably be consistent with Nobel Prize winners' overall positive emotions, prudence, mindfulness and equanimity about their work, perhaps even their lives. Quoting a few paragraphs from one banquet speech to help illustrate:

> In looking toward the future, our generation of scientists has come to believe that the biology of the mind will be as scientifically important to this century as the biology of the gene has been to the 20th century. In a larger sense, the biological study of mind is more than a scientific inquiry of great promise; it is also an important humanistic endeavor. The biology of mind bridges the sciences - concerned with the natural world - and the humanities - concerned with the meaning of human experience. Insights that come from this new synthesis will not only improve our understanding of psychiatric and neurological disorders, but will also lead to a deeper understanding of ourselves.
>
> Indeed, even in our generation, we already have gained initial biological insights toward a deeper understanding of the self. We know that even though the words of the maxim are no longer encoded in stone at Delphi, they are encoded in our brains. For

> centuries the maxim has been preserved in human memory by these very molecular processes in the brain that you graciously recognize today, and that we are just beginning to understand.
>
> On a personal note, allow me to thank Your Majesties, on behalf of all of us, for this splendid evening, and to raise a toast to self-understanding. Skoal! (Kandel, 2000)

Significance and Ramifications

Nobel Prize winning scientists may serve as exceptional examples not just for how to best approach research from a cognitive standpoint, but from an emotional perspective as well. This would probably have significant ramifications that might serve to improve both the work and lives of scientists in general. The aim of this study was to see if content analysis of attributional statements may be an accurate and practical means to reveal whether a basically optimistic approach to research serves the scientist better than a pessimistic one. The hypotheses expected so based on many grounds such as Broaden and Build theory, which leads to the further expectation in scientific research, where creativity is often vitally important, that positive emotions are then more apt to bring about innovation than negative emotions. Still in science, more often than not, high creativity produces a plethora of ideas, the majority of which do not work out in the long run, which to a pessimistic scientist can be especially frustrating, even discouraging; however, the optimistic scientist is likely as well to be resilient in the face of disappointing outcomes and more likely to treat them instead as potential learning opportunities. Such an attitude may be essential to context-sensitive defensive pessimism. Signs of positive emotions in general and resilience in particular ought to appear in scientists’ explanatory styles. An optimistic scientist is more apt to take calculated risks in acting on new ideas, while a pessimistic one would be more likely to be passive, risk-averse and hence less willing to take the risks inherent to productive research that has impact.

The results of this study may help in the custom-design of especially effective creativity and resilience training for research scientists, perhaps as an adjunct to their graduate school education, or leadership courses in R&D organizations. A broad view of the Nobel laureates’ attributional statements shows some evidence for engagement, meaning and intrinsic rewards as very important to eminent scientists, perhaps then to scientists in general. Adequate extrinsic compensation for scientists’ research work of course is a necessary condition for them to be engaged and productive, but it is not sufficient. Further work on explanatory styles of top researchers may build further impetus to design novel compensation systems for scientists that take more into account their predisposition to seek engagement and meaning in their work.

For Further Study

The study reported here focused on all the chemistry Nobel laureates' speeches but only a sampling of the physiology or medicine speeches for comparison. Further study would have to examine all the physiology or medicine speeches, those of physics, perhaps economics as well. Doing so would bring more power to the comparative results to reveal more about how well the different disciplines may be faring compared to their perceived performance years ago as revealed in verbatim explanations of their top scientists. Physics might for example have had a perceived decline just before its resurgence owing to the emergence of quantum mechanics in the first half of the twentieth century. Chemists may see their field in decline lately, perhaps with concern of its being subsumed into other fields like physiology or medicine. Even the existing data would need more detailed analysis to find indications of the recent state of chemistry in comparison with other fields. Further examination of speech content may shed light on these issues and lead to insights that help scientists build their abilities at innovation.

The nobelprize.org website also includes biographies and autobiographies of most of the laureates, which could get their own content analysis and examination for health, longevity and accomplishments both before and after the Nobel award.

Finally, because of their probable concern for the health of science, some living Nobel winners may be willing to complete the ASQ survey for sake of comparing its results with the CAVE results from both their banquet speeches as well as autobiography content (Peterson, et al. 1982). Doing so might reveal more about the precise impact of context on scientists' explanatory styles, their levels of optimism, and affinity for scientific research.

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Table 1

Significance of difference test, chemistry vs. physiology or medicine.

Anova: Single Factor (alpha=0.05)

SUMMARY	negativity			
Groups	Count	Sum	Average	Variance
Chem	79	175	2.215	1.966
Phys-Med	41	102	2.488	1.406

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.006	1	2.006	1.129	0.290	3.921
Within Groups	209.586	118	1.776			
Total	211.592	119				

SUMMARY	internality			
Groups	Count	Sum	Average	Variance
Chem	79	357	4.519	2.766
Phys-Med	41	173	4.220	3.676

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.421	1	2.421	0.787	0.377	3.921
Within Groups	362.746	118	3.074			
Total	365.167	119				

SUMMARY	controllability			
Groups	Count	Sum	Average	Variance
Chem	79	243	3.076	1.610
Phys-Med	41	142	3.463	2.805

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	4.052	1	4.052	2.011	0.159	3.921

Table 1
(cont'd.)

Within Groups	237.739	118	2.015			
Total	241.792	119				

SUMMARY	globality			
Groups	Count	Sum	Average	Variance
Chem	79	482	6.101	1.297
Phys-Med	41	261	6.366	0.538

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.890	1	1.890	1.817	0.180	3.921
Within Groups	122.702	118	1.040			
Total	124.592	119				

SUMMARY	stability			
Groups	Count	Sum	Average	Variance
Chem	79	376	4.759	1.954
Phys-Med	41	216	5.268	2.201

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	6.988	1	6.988	3.429	0.067	3.921
Within Groups	240.479	118	2.038			
Total	247.467	119				

Table 2

Chemistry plus physiology or medicine

Attributional statements: Totals and averages

	All (N=120)		Pos (N=103)		Neg(N=14)	
	Avg	SD	Avg	SD	Avg	SD
Negativity	2.31	1.33	1.84	0.72	5.36	0.73
Internality	4.42	1.75	4.40	1.77	4.36	1.74
Controllability	3.21	1.42	3.21	1.41	2.71	1.20
Globality	6.19	1.02	6.20	1.00	6.21	1.12
Stability	4.93	1.44	4.82	1.45	5.71	1.14

Neutral statements, (rating=4), N=3

Table 3

Chemistry plus physiology or medicine

Intercorrelations: Pos. events only (N=103)

	Int	Con	Glo	Sta
Int	1			
Con	0.45	1		
Glo	0.11	0.16	1	
Sta	0.31	0.33	0.40	1
Mean	4.40	3.21	6.20	4.82
SD	1.77	1.41	1.00	1.45

Table 4

Examples of Nobel Scientists' Attributional Statements for Positive Events

It is, at the same time, an honour which brings with it a sense of humility … *Negativity=2* *Internality=5* *Controllability=3* *Globality=6* *Stability=5*	We all know that chance, fortune, fate or destiny - call it what you will has played a considerable part in many of the great discoveries in science. *Negativity=3* *Internality=5* *Controllability=2* *Globality=7* *Stability=6*
… there are many analogies between the sport of skiing, which I dearly love, and doing theoretical work in science - the challenge and sense of excitement when the slope is a little more difficult than one feels comfortable with, or the boredom if too easy, or the probable disaster if too difficult. *Negativity=3* *Internality=6* *Controllability=3* *Globality=6* *Stability=4*	For centuries the maxim ["Know thyself"] has been preserved in human memory by these very molecular processes in the brain that you graciously recognize today, and that we are just beginning to understand. *Negativity=3* *Internality=6* *Controllability=2* *Globality=7* *Stability=6*
We do know, though, that in many cases it was a chance observation which took them into a track which eventually led to a real advance in knowledge or practice. *Negativity=2* *Internality=6* *Controllability=3* *Globality=7* *Stability=6*	We are rewarded for work the very essence of which is that we were so impatient that we spent only a millionth of a second over an experiment. *Negativity=2* *Internality=5* *Controllability=3* *Globality=6* *Stability=3*

Table 5 Examples of Nobel Scientists' Attributional Statements for Negative Events

Today, the pace of scientific discovery is quickening as never before and the consequences of the revelations that are emerging promise to influence our future in myriad ways. And yet, these advances have revealed or perhaps created an underlying apprehension and a questioning of whether certain inquiries at the edge of our knowledge, and our ignorance, should cease for fear of what we could discover or create.
Negativity=6
Internality=5
Controllability=3
Globality=7
Stability=6

Lack of scientific fundamentals causes people to make foolish decisions about issues such as the toxicity of chemicals, the efficacy of medicines, the changes in the global climate.
Negativity=6
Internality=5
Controllability=5
Globality=7
Stability=6

We, Homo sapiens, now are destroying the other species that presently exist on this planet at a rate of about 15,000 to 20,000 per year. Given that the current estimate of the total number of species on the planet is about 2 million, this rate, by the end of the next century, will be equivalent in biological effect to the catastrophic event(s) … the kind of mass extinction that … required 5 million years for recovery, such recovery resulting in a completely different biota from that preceding it.
Negativity=7
Internality=7
Controllability=2
Globality=7
Stability=6

References

Becker, L.A. (2001). Discussion notes: Causation. Unpublished class notes. Retrieved from the Web, University of Colorado, Colorado Springs.

Burns, M. O., & Seligman, M. E. P. (1991). *Explanatory style, helplessness, and depression*. Elmsford, NY, US: Pergamon Press.

Burns, M. O., & Seligman, M. E. (1989). Explanatory style across the life span: Evidence for stability over 52 years. *Journal of personality and social psychology, 56*, 471-477.

Edwards, J. R., Baglioni, A. J., & Cooper, C. L. (1990). Examining the relationships among self-report measures of the type A behavior pattern: The effects of dimensionality, measurement error, and differences in underlying constructs. *Journal of Applied Psychology, 75*, 440-454.

Edwards, J. R., & Baglioni, A. J. (1991). Relationship between type A behavior pattern and mental and physical symptoms: A comparison of global and component measures. *Journal of Applied Psychology, 76*, 276-290.

Fisher, David James (1988). *Romain Rolland and the Politics of Intellectual Engagement.* Berkeley: University of California Press. http://ark.cdlib.org/ark:/13030/ft538nb2x9/

Fredrickson, B. L., & Losada, M. F. (2005). Positive affect and the complex dynamics of human flourishing. *American Psychologist, 60*, 678-686.

Friedman, M., & Rosenman, R. H. (1959). Association of specific overt behavior pattern with increases in blood cholesterol, blood clotting time, incidence of arcus senilis and clinical coronary artery disease. *The Journal of the American Medical Association, 169,* 1286-1296.

Ghiselin, B. (1952). *The Creative Process.* New York: Mentor.

Isaacson, W. (2007). *Einstein: his life and universe*. New York: Simon & Schuster.

Kandel, E. (2000) Nobel Prize banquet speech. *Les Prix Nobel. The Nobel Prizes 2000*, Frängsmyr, T. (ed.) Nobel Foundation, Stockholm, 2001 Copyright © The Nobel Foundation.

Lee, F., Peterson, C., & Tiedens, L. Z. (2004). Mea culpa: Predicting stock prices from organizational attributions. *Personality and Social Psychology Bulletin, 30*, 1636-1649.

Martin-Krumm, C. P., Sarrazin, P. G., & Peterson, C. (2005). The moderating effects of explanatory style in physical education performance: A prospective study. Personality and Individual Differences, 38, 1645-1656.

Martin-Krumm, C. P., Sarrazin, P. G., Peterson, C., & Famose, J. (2003). Explanatory style and resilience after sports failure. Personality and Individual Differences, 35, 1685-1695.

McCann, S. J. H. (2001). The precocity-longevity hypothesis: Earlier peaks in career achievement predict shorter lives. *Personality and Social Psychology Bulletin, 27*, 1429-1439.

National Academy of Sciences (2007) The Future of U.S. Chemistry Research: Benchmarks and Challenges. National Research Council Report, Executive Summary. Downloaded from the web: http://books.nap.edu/catalog/11866.html

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological review, 84*, 231-259.

Oettingen, G., & Seligman, M. E. (1990). Pessimism and behavioural signs of depression in East versus West Berlin. *European Journal of Social Psychology, 20*, 207-220.

Park, N., Peterson, C., & Seligman, M. E. P. (2006). Character strengths in fifty-four nations and the fifty US states. *The Journal of Positive Psychology, 1*, 118-129.

Pennebaker, J. W., Slatcher, R. B., & Chung, C. K. (2005). Linguistic markers of psychological state through media interviews: John Kerry and John Edwards in 2004, Al Gore in 2000. *Analyses of Social Issues and Public Policy (ASAP), 5*, 197-204.

Peterson, C. (2006). *A primer in positive psychology*. New York, NY, US: Oxford University Press.

Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues: A handbook and classification*. Washington, DC, US: American Psychological Association; New York, NY, US: Oxford University Press.

Peterson, C., & Seligman, M. E. (1987). Explanatory style and illness. *Journal of Personality. Special Issue: Personality and physical health, 55*, 237-265.

Peterson, C., Semmel, A., Von Baeyer, C., Abramson, L. Y., Metalsky, G. I., & Seligman, M. E. P. (1982). The attributional style questionnaire. *Cognitive Therapy and Research, 6*, 287-300.

Pezzo, M. V., & Pezzo, S. P. (2007). Making sense of failure: A motivated model of hindsight bias. *Social Cognition, 25*, 147-164.

Rettew, D., & Reivich, K. (1995). *Sports and explanatory style*. Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Romain Rolland (1920). Un livre de Raymond Lefebvre *Le Sacrifice d'Abraham. L'Humanité,* 1.

Satterfield, J. M., Monahan, J., & Seligman, M. E. P. (1997). Law school performance predicted by explanatory style. *Behavioral sciences & the law, 15*, 95-105.

Simonton, D. K. (2003). Qualitative and quantitative analyses of historical data. *Annual Review of Psychology, 54*, 617-640.

Simonton, D. K. (1999). Significant samples: The psychological study of eminent individuals. *Psychological methods, 4*, 425-451.

Simonton, D. K. (1988). Age and outstanding achievement: What do we know after a century of research? *Psychological bulletin, 104*, 251-267.

Sternberg, R. J. (Ed.) (2002). *Why smart people can be so stupid.* New Haven, CT, US: Yale University Press.

Zullow, H. M., Oettingen, G., Peterson, C., & Seligman, M. E. (1988). Pessimistic explanatory style in the historical record: CAVing LBJ, Presidential candidates, and East versus West Berlin. *American Psychologist, 43*, 673-682.

Anonymous (2007). Description of numeric improvement in Analysis ToolPak ANOVA tool in Excel. Retrieved from the web. http://support.microsoft.com/kb/829215/

Anonymous (2007). The official web site of the Nobel Foundation. Copyright © 2007 The Nobel Web AB. http://nobelprize.org/index.html

Appendix

Extraction of Attributional Statements: Instructions to Coders

An *attributional statement* is a causal explanation for an event. Attributions and events are often (but not always, *vide infra*) linked by phrases indicative of causation, like: *because of*, *resulting in* or *led to*. Where such phrases may not clearly exist, you will likely need to pay close attention to the context in which the possible attributional statement resides.

So, you are strongly advised to use David Hume's three conditions for inferring cause (Becker, 2001):

1. *Contiguity* (nearness or contact; continuous mass or unbroken series) between presumed cause and effect;
2. *Temporal* precedence, in that the cause had to precede the effect in time; and
3. *Constant* conjunction, in that the cause had to be present whenever the effect was obtained.

===

Some example statements:

The profits we are making now **are the result of** years of investment and the money we're investing won't produce returns for several years to come.

I'm also very conscious that our own perspective shifts **as** the growth of our business changes the relationships we have in different countries around the world.

But we don't see recognition as a victory. We see it as confirmation that we're moving in the right direction and as encouragement to continue.

Because of [our] products like Kevlar® and Nomex®, we've seen the market for personal protection products continue to grow around the world.

We are in our 204th year as an enterprise and have grown and moved in directions that our predecessors would find surprising. But what wouldn't surprise them is the innovation and creativity - rooted in a foundation of values - that has taken us in those directions.

Some words that are often indicators of the attributional statements in which they may be found are listed in the table:

Causal nouns/fragments:	Causal verbs/fragments:	Conjunction fragments:
reason	make happen	since
cause	led to	because
result of	bring about	for the reason that
root	produce	
basis	set off	
grounds	instigate	
	begin	
	initiate	
	affect	

Rating of Attributional Statements: Instructions to Coders

An *attributional statement* is a *causal* explanation for an event. Attributions and events are often (but not always, *vide infra*) linked by phrases indicative of causation, like: *because of*, *resulting in* or *led to*.

David Hume's three conditions for inferring <u>cause</u> are:

1. *Contiguity* (nearness or contact; continuous mass or unbroken series) between presumed cause and effect;
2. *Temporal precedence*, in that the cause had to precede the effect in time; and
3. *Constant conjunction*, in that the cause had to be present whenever the effect was obtained.

Rate each attributional statement in terms of:

a) *negativity* of the event being explained
b) controllability (how much the cause is controllable by the person or institution)
c) globality (how much the cause affects a wide domain of the person's or institution's activities)
d) internality (how much the cause resides within the person or institution)
e) stability (how much the cause is a non-changing, enduring condition)