REVIEWS

Determining Whether a Patient is Feeling Better: Pitfalls from the Science of Human Perception

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Human perception is fallible and may lead patients to be inaccurate when judging whether their symptoms are improving with treatment. This article provides a narrative review of studies in psychology that describe misconceptions related to a patient's comprehension, recall, evaluation and expression. The specific misconceptions include the power of suggestion (placebo effects), desire for peace-of-mind (cognitive dissonance reduction), inconsistent standards (loss aversion), a flawed sense of time (duration neglect), limited perception (measurement error), declining sensitivity (Weber's law), an eagerness to please (social desirability bias), and subtle affirmation (personal control). An awareness of specific pitfalls might help clinicians avoid some mistakes when providing follow-up and interpreting changes in patient symptoms.

KEY WORDS: symptomatic changes; patient follow-up; fallible judgment; medical error; human psychology; eliciting the history.
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INTRODUCTION

One of the most fundamental tasks in medical care is to determine whether the patient is feeling better. Doing so is sometimes a key element in identifying the correct diagnosis, such as when confirming a case of polymyalgia rheumatica with a trial of corticosteroid therapy. It is also a valued element in logical treatment selection, such as when managing a patient with confirmed pyelonephritis and choosing to either continue antibiotics (if the patient is getting better) or switch antibiotics (if the patient is not responding). Repeated observation of individual patients over time is also the traditional way for clinicians to gain personal experience with the course of a disease and prognostic accuracy. Checking patients over time, moreover, is arguably one the most widely applicable methods for mitigating the harm from medical error.

Psychology is the science that examines how people reason, formulate judgments, and make decisions. The purpose of this article is to review concepts from psychological science that are entrenched in psychology textbooks and that might inform judgments in medicine concerning changes in symptoms. We focus on implications of this basic science that have special relevance to health, counterintuitive features, and more than 3,000 citations on Google Scholar. The narrative review excludes studies related to conflicts of interest, idiosyncratic personality, careless judgment, or interpreting objective data [1]. We also exclude studies on evaluating one patient at one occasion [2,3]. We do not cover all available territory because the terrain is too large, varied, and undiscovered for a succinct review to extend beyond a few classic landmarks.

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Placebo Effects

The placebo effect is defined as a change in subjective patient feelings following an inert pharmacological treatment[4]. One historical case from 1774 involves Joseph Priestley who experimented on himself by being the first to generate and inhale pure oxygen [5].His seminal article states "my lungs … felt particularly light and easy for some time afterwards". Such a response is implausible based on modern principles of physiology, including lung mechanics and hemoglobin saturation. Apparently, even rigorous scholars are vulnerable to placebo effects and establishing the objective facts can require centuries of subsequent research. This example also shows that complete refutation is sometimes not possible, given the continued existence of "oxygen bars" catering to individuals pursuing lifestyle improvement [6].

One classic demonstration of the placebo effect involved volunteers participating in an experiment involving arm pain caused by a series of ultrasound heat probes [7]. In advance, some participants were given a special multicolor pill that was claimed to increase pain tolerance. The pill was actually pharmacologically inert. Each participant underwent multiple trials and reported the amount of time required for the pain to become noticeable. The main finding was that participants took about 50% longer to notice pain if they had received the pill than if they had not (52 seconds vs. 35 seconds, $p<0.05$). Similar differences were also observed in the time required for the pain to become unbearable. Apparently, conscious (or subconscious) expectations can distort the reporting of subjective symptoms or augment the effects of real changes.

Placebo effects need to be recognized in daily practice if patients are aware of treatments, have set expectations, and attach meanings [8]. For example, as much as 75% of the apparent benefit of an antidepressant is perhaps related to placebo effects [9,10]. Similarly, some patients who undergo sham

vertebroplasty experience substantial relief of back pain following the procedure [11]. A savvy clinician, therefore, would avoid over-estimating the effectiveness of a treatment that might also act by indirect psychological factors [12]. The placebo effect also underscores a role for diligent patient examination to corroborate symptom changes with objective data [13]. A definitive solution is to undertake more placebo controlled treatments on individual patients in daily practice, and yet such trials are underutilized even among advocates [14–17].

Cognitive Dissonance Reduction

Some medical interventions are sufficiently unpleasant that the patient is blatantly aware of treatment and a placebo would be infeasible. In such cases where people choose and endure an unpleasant experience, individuals may subsequently reconcile themselves by exaggerating the resulting benefits (a phenomenon termed "cognitive dissonance reduction") [18]. After a course of noxious chemotherapy for breast cancer, for example, some women may be unduly confident about having conquered cancer [19–21]. Whereas a degree of optimism may be productive, an exaggerated false sense of security could theoretically jeopardize subsequent patient outcomes by contributing to lapses in follow-up appointments, gaps in long-term medication adherence, or denial over a possible recurrence [22–24].

One psychology experiment demonstrating cognitive dissonance reduction involved overweight adults enrolled in a dietary counseling program that involved cognitive tasks done twice weekly for one hour [25]. By random assignment, half were assigned distinctly unpleasant tasks (e.g., reciting awkward passages with distorted noisy auditory feedback) whereas the other half were assigned easier cognitive tasks (e.g., reciting the same passages with no disruptive auditory distractions). At six month's follow-up, individuals who had faced the relatively unpleasant tasks had lost more weight than those who had faced the easier tasks (8.5 lbs vs. 0.1 lbs, $p<0.001$). Apparently, people who endure a distinctly unpleasant challenge may rationalize their experiences by subsequently viewing their treatment as relatively valuable.

Cognitive dissonance reduction has perhaps intensified in modern medical care because of shared decision-making [26]. Patients with complications following breast cancer treatment, for example, are less likely to express regret if the initial discussion was their choice rather than the physician's [27,28]. Arguably, some of this psychology also drives community activism by cancer survivors or transplant recipients who strongly believe the outcomes were worth the trouble [29–32]. A patient who actively seeks a major treatment may become as deeply convinced as a college student who endures a tough initiation and later becomes passionately loyal to their fraternity [33]. One method to reduce spurious symptom changes due to cognitive dissonance reduction is to adopt care plans that maintain patient comfort and do not foster cognitive dissonance.

Loss Aversion

Loss aversion occurs because of people's tendency to isolate gains and losses, establish separate accounts for specific domains, and focus attention toward liabilities [34]. A person who wins $100 in a lottery and loses $80 in another, for example, feels less happy than a person who wins $20 in a single lottery [35]. In medicine, such loss aversion can lead to potential biases where a change in one symptom overshadows changes in other symptoms. An emergency department patient with acute asthma who receives effective bronchodilators yet is treated rudely by staff, for example, may still complain of ongoing distress and leave against medical advice [35]. In such a case, the symptom improvement from treatment is overshadowed by the emotional discomfort from disrespectful human interactions.

One frequently cited experiment demonstrating mental accounting involved participants who read complex descriptions of characters that contained three positive features (e.g., kindness) and three negative features (e.g., dishonesty) [36]. Participants were surveyed one week later and asked to recall all the features of the character in as much detail as possible. The main finding was that the average participant remembered fewer of the positive features than the negative features (1.86 vs. 2.12, $p<0.01$). Moreover, the negative features were remembered with more confidence and more accuracy than positive features. Apparently, individual positive and negative features are not integrated together; instead, negative features receive disproportionate attention and can create a somewhat jaundiced summary evaluation.

The simple solution to loss aversion is to encourage people to keep setbacks in perspective and appreciate the big picture [37–39]. This logical strategy is not always easy for a patient who is sick or in pain. One way the physician can provide some solace is by being explicit about what has gone well, such as the patient's absence of heart failure or preservation of normal kidney function [40]. Another strategy is to distinguish between the patient's symptoms and the patient's goals [41]. Conversely, the strategy of providing excessive details and overwhelming risk information to patients can sometimes lead to worsening anxiety and decreased patient satisfaction [42]. Ultimately, clinicians need to anticipate that patients will often view worsening symptoms as more intense than the corresponding improvements [43].

Duration Neglect

Some diseases have only one major symptom that fluctuates in intensity; however, even straightforward experiences are prone to perceptual errors when judged in retrospect. One of the most remarkable biases is the tendency for people to judge an overall event by considering its general severity with insufficient accounting for its relative duration, a phenomenon termed duration neglect [44]. The failure to remember time passing after it has passed, for example, creates a poignant illusion where parents feel "my child grew up in the blink of an eye". Similarly, many patients remember their colonoscopy as either mild or painful yet seem to forget whether their procedure lasted a few minutes or a full hour [45]. Women in labor, as well, can be emphatic about describing intense uterine contractions yet uncertain about judging their relative timing [46].

One study of duration neglect involved patients who underwent standardized shock wave lithotripsy for kidney stones and subsequently reported the total amount of pain experienced from treatment [47]. The specific follow-up survey emphasized a holistic summary measure and used a 10-point visual

analogue scale where 0 indicated "No discomfort" and 10 indicated "Awful discomfort". The actual duration of lithotrispy treatment varied substantially, ranging from 18 minutes for some patients to 51 minutes for other patients. Patients who had longer than average treatments, however, reported about the same total amount of pain as patients who had shorter than average treatments (4.5 vs. 5.1, p=0.128). That is, unpleasant experiences which were relatively prolonged were not necessarily remembered as especially aversive.

The way to correct for duration neglect is to measure time in an objective manner. Deciding whether a triptan or other drug is effective for a patient's migraine headaches is, perhaps, best settled with an objective recording of the frequency and duration of attacks [48–50]. Similarly, a clock or timer in the outpatient clinic might show patients how much time the physician spent with them during their appointment, contrary to a sometimes mistaken impression afterwards that time flew by [51,52]. Patients who undergo general anesthesia, as well, need to be told the duration of the surgery since this is one factor that people cannot observe for themselves (yet predicts many aspects of their subsequent recuperation) [53]. Duration neglect is one of the few pitfalls in assessing symptom changes that can be rapidly addressed with available technology.

Measurement Error

Measurement error prevails in human perception and is defined as the fallible nature of observations that creates latent imprecision in subsequent information [54,55] . The speed of light can be measured with near perfect precision, but not the intensity of a patient's nausea. Indeed, the fluctuating nature of normal biological systems injects an inescapable degree of variability into most clinical symptoms. Some patients, as well, find it unnerving to concentrate hard on their deficits. Finally, the rushed nature of medical practice curtails the opportunities for the meticulous quantification that typifies pure science. Consequently, patients who describe their chest pain as decreasing from a "5" to a "4" need to be monitored repeatedly to determine if the apparent favorable trend will continue.

The fallible nature of how people sense differences can be demonstrated in perception tasks that are objective, familiar, innocuous, and extremely simple. The Muller–Lyer illusion, for example, shows that people often err when estimating the distance between two points (faulty length discrimination). The result is that people underestimate the length of a line that terminates with outward-pointing arrowheads and overestimate the length of a line that terminates with inward-pointing arrowheads. The illusion is robust and, indeed, also occurs in monkeys and pigeons [56,57]. Training with up to 200 repetitions can attenuate the degree of misperception, albeit with some residual inaccuracy [58–60]. Interestingly, a combination of raised awareness with further practice can sometimes lead to greater accuracy [61].

Measurement error in science is rectified by obtaining multiple independent observations, akin to serial temperature charting to identify a periodic fever in malaria patients. These methods are often skirted in medical care because clinicians may be reluctant to wait days before starting treatment [62]. Medical care may also involve problems due to missing data and a lack of independent observation, such as when body weights are recorded in a sloppy manner for hemodialysis patients [63]. The need for consistent repetitive assessment of symptoms is a somewhat unexciting task where people are not robots and, instead, need ongoing encouragement [64]. In addition, automated technology such as a home thermometer or sphygmomanometer might help patients more reliably record times when they feel feverish or hypertensive [65,66].

Weber's Law

Sometimes even repeated observations are fallible because of the limits of sensory perception. Weber's law states that a slight change in a stimulus is more easily detected when baseline levels of the stimulus are small rather than large [67]. This general principle of declining levels of sensitivity is familiar to clinicians; for example, a 10 kg loss of body weight is more noticeable if it is a decrease from 70 to 60 kg rather than from 170 to 160 kg. More than a century of research has found that this law holds across diverse sensory modalities including hearing, sight, taste, touch, smell, and pain [68]. Weber's law is relevant to medicine because most patient symptoms are actually graded perceptions that range, for example, from mild to severe.

The most widely cited demonstration of Weber's law involved college students assessing the weights of solid objects identical in size but differing in mass [69]. In each trial, the participant lifted two objects and judged whether the second was heavier, lighter, or the same weight as the first. Weights varied from 25 to 600 grams and each participant underwent 250 total trials of paired comparisons. The main finding was that participants became increasingly uncertain about judging small differences as the average weight increased. For example, the average participant could notice a difference as small as 2 gram when holding a 25 gram load but could not notice a difference less than 25 gram when holding a 600 gram load. Small differences seem to go unnoticed even though, if accumulated, they can result in a substantial final total.

The way to address Weber's law in clinical practice is to provide objective measures to supplement subjective self-report. A patient with advanced pulmonary fibrosis, for example, may be unable to detect large changes in airway tract resistance; hence, serial pulmonary function tests can offer a more exact determination of their course [70]. Similarly, a patient who states an unchanged degree of fatigue might benefit from serial six-minute walking tests [71]. Three caveats regarding objective measures include a lack of availability (e.g., no objective test can quantify a patient's hip pain), poor accuracy (e.g., blood gas measurements correlate poorly with dyspnea in asthma patients), and relative safety (e.g., serial liver biopsy can be risky in patients with cirrhosis). Hence, standard medical textbooks almost never mention Weber's law [72].

Social Desirability Bias

Social desirability bias is defined as the natural propensity to answer questions in ways that are socially acceptable rather than completely truthful [73]. The possible range of latent emotional impulses can range from silent embarrassment to outright fear of retaliation. The net effects in medicine can result, for example, in patients overstating their adherence with medication therapy, dietary restrictions, exercise advice, or smoking cessation. In theory, such distortions might be accentuated for patients in especially vulnerable positions such as those in pediatric,

geriatric, or psychiatric settings. The situation is unlikely to disappear in any setting if patients are concerned about their reputation and feel dependent on medical care.

One repeated method for demonstrating reporting bias involves questioning adults about their voting behavior and comparing verbal reports to actual voting records. For example, a meta-analysis of American presidential and congressional elections from 1964 to 1990 used national sampling and face-to-face interviews to assess voting behavior in the aftermath of each election [74]. The main finding was that about 52% of people said they had voted and the official election office record agreed, 38% said that they had not voted and the record agreed, and 10% said that they had voted but the record showed otherwise. This implies that about one in six of those who claimed to have voted had not actually voted. Apparently, social desirability bias causes people to minimize their perceived failures even in mild interviews.

The way to prevent this type of misleading self-report in medicine is to use excellent communication skills to encourage honest reports [75]. However, this is a major challenge since the average person tells a significant lie around twice a day under normal circumstances [76]. The plea for honesty in medicine may also fail because most patients care what the doctor thinks of them [77]. Emphasizing the privacy of doctor–patient communication can help somewhat [78]. The patient also has to worry about potential hassles from allied professionals; hence, the entire team needs to foster a climate of positive rapport that establishes trust [79]. Like other artifacts from self-presentation, liberal doses of pre-emptive compassion, understanding, reassurance, neutrality, and patience have been found to elicit more honest responses in survey research [80–83].

Personal Control

Pitfalls in self-report often relate to social desirability bias, cognitive dissonance, or simple misunderstandings; however, some nuances are much more subtle because self-expression is a form of personal control. People enjoy their autonomy and tend to be more satisfied when an experience is self selected rather than externally imposed (a phenomenon termed "self-determination") [84]. Overbearing parents, for example, can take the fun out of a playful activity by an ill-timed prompt that prevents their children from exercising their own initiative [85]. Conversely, patient controlled analgesia can result in more relief than conventional analgesia after surgery because patients have a sense of control rather than a feeling of dependency [86]. A perceived loss of personal control, for some individuals, is one of the most disturbing aspects of clinical depression [87].

One frequently discussed laboratory demonstration on the importance of self determination involved pairs of college students asked to submerge their right hand in an ice water bath [88]. To help distract participants from the discomfort, each was shown a series of slides depicting colorful landscapes and foreign landmarks. By random assignment, half the participants controlled the presentation of each slide whereas the other participants had the slides change automatically based on the timing of a prior participant. The main finding was that those who controlled the rate of presentation tolerated the ice water longer than those in the comparison group (149 seconds vs. 100 seconds, $p<0.01$). Apparently, having some sense of control can make a person feel more resilient even if what they control is unrelated to the aversive exposure.

In medicine, a sense of personal control may be growing in modern times due to patient support groups, on-line medical records, consumer based choice, and other real advances [89,90]. Even in classical times, however, the reciprocal nature of follow-up visits automatically gave patients some perceived self-determination [91]. A doctor who asks "How are you feeling now after treatment?", for example, causes patients to both reflect on their symptoms and to receive a tacit endorsement for their views. That is, the act of returning to the patient at follow-up implicitly conveys to the patient some affirmation and respect [92,93]. All these

Table 1. Avoiding Pitfalls when Checking Patients at Follow-Up

Task	Error	Example	Solution	Example
Comprehension	Placebo effects	Doctor: "Did the pill work?" Patient: "I felt better after the very first dose!"	Corroborate symptoms with objective data	Doctor: "Well, let's check your blood pressure and see if it's improved too."
	Cognitive dissonance reduction	Doctor: "Did the surgery work?" Patient: "Recovery was awful, but worth it."	Give the patient ways to save face	Doctor: "Well I thought it was the best option, but I worried I had pressured you."
Recall	Loss aversion	Doctor: "How are you?" Patient: "Worse. My pain is gone, but I can't sleep."	Check both the big picture and the specific details	Doctor: "Let's check all separate symptoms, as well as the overall situation too."
	Duration neglect	Doctor: "How long do these episodes normally last?" Patient: "Too long."	Ask for an objective time record of duration	Doctor: "Could you or your spouse start a record of these episodes?" Patient: "OK."
Evaluation	Measurement error	Doctor: "I'm going to check your blood pressure." Patient: "OK."	Get multiple independent observations	Doctor: "The nurse and I will both check your blood pressure." Patient: "OK."
	Weber's Law	Doctor: "How's your dizziness?" Patient: "Still quite bad."	Expect patients with intense symptoms to take longer to feel better	Doctor: "Patients with dizziness need time before noticing a real improvement."
Expression	Social desirability bias	Doctor: "Have you been taking your pills like I told you to?" Patient: "Yes."	Offer preemptive compassion	Doctor: "Patients have a hard time taking pills. Is that true for you too?" Patient: "Yes, a bit."
	Personal control	Doctor: "I want you to take this medication." Patient: "OK."	Foster choice and self-determination	Doctor: "There are two medications you could try." Patient: "Tell me about each."

intangibles can help make a patient feel better with no objective medical changes [94–96]. These intangibles are not necessarily detrimental yet the gains should not always be credited to biomedical intervention [97].

SUMMARY

This article reviews eight concepts from psychology that are relevant when checking whether a patient feels better at follow-up. The theme is that judgment can be inaccurate even if patients assess their symptoms in a manner that seems confident and cannot be refuted. The concern is when clinicians overreact to such judgments and make a faulty decision about a patient's overall response. An awareness of specific patterns of mistakes might lead to better clinical outcomes and fewer complications in medical care (Table 1). Awareness of pitfalls is no reason to discard the patient's perspective any more than knowledge of visual illusions is no justification for practicing dermatology with closed eyes.

The largest limitation of our research is that it is not a systematic review of all psychology research. The field is so broad and variable, for example, that formal meta-analyses would fail simple tests for heterogeneity. We selected concepts that have stood the test of time and thereby did not include recent findings that have early enthusiasm but not widespread replication. Our conservative approach, moreover, was constrained so that two examples appeared for each element in the underlying four-part framework (comprehension, recall, evaluation and expression). Finally, we focused on counter-intuitive concepts relevant to how people perceive changes over time rather than concepts important when evaluating one person at one time [98].

Our review also highlights opportunities for future research that tests psychological concepts in medical domains. We focused on a small set of concepts and yet could not always identify a rigorous clinical trial for each. The dearth of medical data might reflect a lack of research funding from conventional biomedical sources, a flimsy effect size when extended beyond laboratory settings, or a lack of awareness among clinician scientists. We believe these concepts merit further testing to determine the degree to which they might lead to better outcomes for medical patients [99,100]. In the interim, an awareness of specific pitfalls in human perception might help prevent some mistakes when checking patients at follow-up.

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