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# Believing Is Seeing: Using Mindlessness (Mindfully) to Improve Visual Acuity

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## Abstract

These experiments show that vision can be improved by manipulating mind-sets. In Study 1, participants were primed with the mind-set that pilots have excellent vision. Vision improved for participants who experientially became pilots (by flying a realistic flight simulator) compared with control participants (who performed the same task in an ostensibly broken flight simulator). Participants in an eye-exercise condition (primed with the mind-set that improvement occurs with practice) and a motivation condition (primed with the mind-set "try and you will succeed") demonstrated visual improvement relative to the control group. In Study 2, participants were primed with the mind-set that athletes have better vision than nonathletes. Controlling for arousal, doing jumping jacks resulted in greater visual acuity than skipping (perceived to be a less athletic activity than jumping jacks). Study 3 took advantage of the mind-set primed by the traditional eye chart: Because letters get progressively smaller on successive lines, people expect that they will be able to read the first few lines only. When participants viewed a reversed chart and a shifted chart, they were able to see letters they could not see before. Thus, mind-set manipulation can counteract physiological limits imposed on vision.

**Keywords**

vision, mindfulness, mind-sets, mindlessness, cognition

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Contrary to the assumption that vision worsens with age because of physiological limitations, the experiments we report here tested whether vision can be improved through psychological means. The constructive nature of visual perception is evidenced through a complementary interaction between *top-down inputs*—including expectations, contextual information, and preexisting networks of knowledge—and *bottom-up stimuli* (Cavanagh, 1991; Engel, Fries, & Singer, 2001; Miller & Cohen, 2001). The contributions of the top-down system point toward the possibility that mindlessness limits visual acuity. Indeed, when participants were shown index cards with slightly altered familiar sayings (e.g., "Mary had a little lamb"), they were blind to the letter repetition (Chanowitz & Langer, 1981; Chun & Marois, 2002). The most dramatic example of "mindless blindness" was an experiment by Simons and Chabris (1999) in which over 50% of the participants, instructed to count the number of passes of two basketballs among team members, failed to see a man in a gorilla suit walk on the court in the middle of a basketball game.

It seems reasonable that stimuli not attended to (nor relevant for one's task) will be swallowed by perceptual darkness, even if the stimuli are dynamic. In addition, if goal-related stimuli are seen as static, even they succumb to invisibility because of neural eye adaptation if the viewer does not make fixational eye movements (Martinez-Conde, Macknik, & Hubel, 2004). In a psychological extension of this neural law, we hypothesized that people would habituate to goal-relevant objects whose meanings are seen as static, making these objects invisible sooner than objects with dynamic meanings. States of mind, particularly those concerning mindless stability versus mindful flexibility of meaning, could directly affect visual perception.

Other cognitive states also have been shown to affect visual processing. In the study of overlearned phrases discussed earlier (Chanowitz & Langer, 1981), we found that although most people did not see the repeated letters on the cards, advanced meditators did. Brown, Forte, and Dysart (1984) also found that advanced practitioners of Buddhist meditation have higher

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visual sensitivity than nonmeditators. Meditators were better able to detect short single-light flashes and required a shorter interval to differentiate between successive flashes correctly in comparison with a control group.

Thus, research suggests that vision may be improved by changes in one's consciousness. We believe that mind-sets regarding vision limit visual performance. Mind-sets are often referred to as cognitive processes that support solving various tasks (see Gollwitzer, Heckhausen, & Steller, 1990), such as visual tasks. They incorporate implicit task-related expectations people hold about actions, behaviors, activities, and people and are often the result of mindless processing of potentially relevant information. Mindlessness (e.g., Langer 1978, 1989, 2002, 2009) is characterized by an absence of active, conscious information processing and reliance on cues that have been built over time or have been appropriated from another source without new interpretations. Research has shown that participants who form such mind-sets perform in accordance with their mindless beliefs, often worsening their outcomes (Chanowitz & Langer, 1981). However, mind-sets can also affect performance positively, as in the case of placebos.

In contrast, mindfulness (e.g., Langer 1978, 1989, 1997, 2002, 2005, 2009) can be defined as active distinction making, a process in which new stimuli are perceived as having continually emerging meanings, rather than fossilized versions of previously held meanings. It has been demonstrated that mindful processing of information results in various positive health-related outcomes, including increased longevity (Alexander, Langer, Newman, Chandler, & Davies, 1989; Langer, 2009; Langer, Beck, Janoff-Bulman, & Timko, 1984; Langer & Rodin, 1976; Rodin & Langer, 1977). In the following research, we tested the hypothesis that visual acuity is limited by mind-sets. In four experiments, we varied mind-sets within the context of visual performance, arguing that an individual's mindfulness might be equally or more powerful than the manipulation of mindless beliefs or mindsets to bring about the physical changes we describe in this report.

It is important to note that mind-sets are not necessarily inaccurate, only inflexible. We used the following mind-sets to test the malleability of visual acuity: (a) pilots have excellent vision, (b) practice improves performance, (c) motivation improves performance, (d) physical fitness improves performance, (e) one will see less as one reads down an eye chart, and (f) one should be able to read the first few lines of an eye chart. By studying the effects of these mind-sets, we extended the priming literature to vision and were able to explore visual acuity in mundane circumstances, allowing for greater generalization. In Study 2, we tested the effect of mind-sets over momentary arousal as the explanation for improvement.

## Study 1

### Experimental overview

To exploit the belief that Air Force pilots have excellent vision, we asked participants in the experimental group to become pilots and fly a flight simulator. We explained that to be a pilot is to become the part being played and not, as in role playing, to have a sense of oneself as separate from that part. Participants in the control group were asked to pretend to fly a flight simulator and role-play being pilots. We hypothesized that the experimental group, with minds more fully in a pilot context, would take on some of the attributes associated with pilots. The attribute we tested was having excellent vision. No mention of vision was made to either group.

In addition, we controlled for the effects of practice and motivation on vision to see if mind-set accounted for additional improvement. To do this, we added two new groups in the study's design. For the first group, we primed the mind-set that practice improves performance. These participants were given eye exercises. For the second group, we primed the mind-set that improvement follows motivation. These participants were asked to read motivational instructions (i.e., "try hard to improve vision"). We hypothesized that the pilot mind-set group would be superior to the eye-exercise group, which in turn would be superior to the motivation group, which would be better than the nonpilot control group.

### Method

***Participants.*** In Study 1a, 19 members of the Reserve Officers Training Corps (ROTC) program at the Massachusetts Institute of Technology (MIT), none of whom were pilots, served as participants. Many ROTC members aspire to become fighter pilots, and a prerequisite for pilot training is 20/20 vision or better. Thus, a ROTC student should strongly associate good vision with pilots. An independent sample of 20 cadets from this population was questioned about the 10 most important characteristics of a pilot; 100% listed vision, and 95% ranked it among the top 3 characteristics. All of the cadets in the experiment had at least 20/20 vision and were randomly assigned to either the experimental group ($n = 10$) or the control group ($n = 9$).

In Study 1b, we attempted to replicate and extend the findings from Study 1a with 44 additional MIT ROTC members. In addition to comparing the control and experimental conditions, we tested the effects of practice and motivation on vision. As determined by an initial eye test, participants in Study 1b had vision between 20/15 and 20/30. Thus, Study 1b included participants with worse-than-average, as well as better-than-average, eyesight.

***Procedure.*** Participants were tested individually. Prior to the manipulation, they were given a standard eye test. To avoid practice effects, we used two different versions of the Snellen eye chart for the initial vision test and for the approaching-aircraft test, in counterbalanced order. The conditions in which the eye tests were administered, such as the lighting, were kept constant for all groups. Participants then completed the procedure in accordance with the group to which they had been assigned.

*Study 1a*. The 10 participants in the experimental, pilot group were brought one at a time into a flight simulator. An actual cockpit including flight instruments was mounted on hydraulic lifts that mimic aircraft movement and performance. A description of some of the basic controls of the airplane (such as the throttle, compass, and artificial horizon) was given. Participants were asked to be Air Force pilots, whatever that meant to them. Toward this end, they were given green army fatigues to wear. Participants were brought into a working simulator and positioned in the pilot's seat. Thus, "flying" the simulator closely approached flying an actual fighter jet.

Participants were seated in the pilot's seat while an experimenter sat in the copilot's seat. While looking at the flight simulator's screen, participants performed simple flight maneuvers. Then, while flying on a straight and level course (with the aid of the experimenter when needed), participants were asked to identify the markings on four plane wings positioned 20 ft outside the front window at eye level. The four schematic wings represented approaching aircraft, and in place of traditional markings, a line from an eye chart was shown on each wing. The eye chart was divided so that each of its bottom four lines (from 20/20 to 20/10) appeared on one wing. Stars were added to the beginning of each line to offer a more realistic effect. Participants were asked to read the letters from each line (the approaching-aircraft eye test). The results of this eye test were recorded, and participants were debriefed.

The 9 participants in the nonpilot control group were treated in exactly the same manner as the experimental group except that they were informed that the simulator was broken but that the experiment would proceed anyway. Participants were asked to take hold of the steering wheel and to play the role of a pilot.

Participants were then asked to simulate the same basic maneuvers as the experimental group was asked to do, except that during this entire sequence the simulator was off. Nevertheless, the participants manipulated the steering wheel as if they were really flying. Finally, as was the experimental group, they were asked to read markings on the schematic plane wings. The results of this eye test were recorded, and participants were debriefed.

*Study 1b*. The cadets were randomly distributed among the pilot ($n$ = 12), nonpilot ($n$ = 11), eye-exercise ($n$ =11), and motivation ($n$ = 10) conditions. For the pilot and nonpilot conditions, the procedures followed were the same as those in Study 1a.

It is a common belief that most skills improve with practice. To see if we could exploit this belief with respect to vision, we asked participants in the eye-exercise group to read a memo called "Visual Acuity Enhancement" after their initial eye test. The memo purportedly had been signed by a major in the U.S. Air Force. It described 10 imaginary "concrete steps" that could be administered to improve eyesight: (a) be seated comfortably, (b) close eyes for 15 s, (c) focus on a point 1 to 1.5 ft away for 10 s, (d) close eyes for 5 s, (e) focus on a point 20 ft away for 10 s (f) close eyes for 5 s, (g) focus on a point 1 to 1.5 ft away for 10 s, (h) blink for 5 s, (i) close eyes for 5 s, and (j) read eye chart. Participants were then brought to the simulator but did not fly it. They were informed that the simulator was not currently working, but that they could proceed without difficulty anyway (they never manipulated the controls). They were then asked to follow the steps outlined in the memo. Colored cards were positioned 1.5 ft and 20 ft away for participants to focus on during the exercises. After completion of the exercises, participants were given the final approaching-aircraft eye test.

To control for how much of the improvement in the pilot group might be the result of simple motivation, we attempted to motivate participants in the motivation group to try to see as well as they possibly could. After the initial eye test, they were told the simulator was broken (they never manipulated the controls), but that the experiment would continue. Once brought into the simulator, participants were asked to read a brief essay on motivation (taken from Winters, 1973). After they finished reading, they were strongly urged to be as motivated as possible and try hard to see the "letters or numbers on the wings of the approaching aircraft." Thus, we primed a mind-set that being motivated means one can see better if one chooses to. After completing the approaching-aircraft eye test, participants were escorted from the simulator and debriefed.

## Results and discussion

In Study 1a, we observed no significant differences between the groups with respect to their initial visual performance. The mean vision pretest score was 20/14.2 for the nonpilot control group and 20/14.2 for the experimental group ($F < 1$). Vision improved for 40% of participants in the experimental group (4 out of 10), but no one in the control group improved (0 out of 9), $\chi^2(1, N = 19) = 4.57$, $p < .05$. In fact, 1 participant in the control group performed worse at retest, whereas no one in the experimental group demonstrated a decline in performance. This finding lends support to our hypothesis that vision may be improved by psychological means. Because all of the participants in the study had average or above-average vision at the start of the study (mean = 20/14.2), the results could imply that interventions of this sort might be used not only to improve below-average performance but also to enhance good performance.

In Study 1b, we included two additional groups, and again there were no significant differences in participants' initial visual acuity. The pretest vision scores were 20/23.2 for the nonpilot group, 20/18 for the motivation group, 20/21.8 for the eye-exercise group, and 20/26.7 for the pilot group ($p > .10$). We found that the following proportions of participants improved their visual performance: 42% (5 out of 12) of the pilot group, 18% (2 out of 11) of the eye-exercise group, 10% (1 out of 10) of the motivation group, and 0% (0 out of 11) of the nonpilot group.

A proportional contrast analysis (see Rosenthal & Rosnow, 1985) matching our hypotheses (that the pilot mind-set group would be superior to the eye-exercise group, which in turn would be superior to the motivation group, which would be better than the nonpilot control group) was significant, $Z = 2.86$, $p < .05$ (one-tailed). The comparison supports the findings from Study 1a. Forty-two percent of the pilot group improved, whereas no one in the nonpilot group showed any improvement, $\chi^2(1, N = 23) = 5.90$, $p < .05$. The pilot group also improved significantly more than the motivation group. Even though this group was encouraged to try as hard as they could to improve their vision, only 1 out of 10 participants in the motivation group improved, $\chi^2(1, N = 22) = 3.8$, $p < .06$. Thus, we found support for the superior effect of the pilot condition over the psychological manipulations of eye exercise and motivation.

Furthermore, we found that people with worse vision improved more than those who began with excellent eyesight, perhaps because they had more room for improvement. Among participants exposed to either the pilot or the eye-exercise manipulations in Studies 1a and 1b, 21 people had 20/20 vision or better. Of these, 23% improved. Of the 12 people who had 20/30 vision (in Study 1b), 50% improved ($p < .05$).

Overall, the findings support the hypothesis that mind-sets influence vision and that implicit mind-sets have a stronger effect than explicit manipulation of motivation. One could argue, however, that vision did not improve because of vision-enhancing mindless beliefs, but rather improved because the pilot group was more aroused than the other groups. To test that hypothesis, we conducted Study 2.

## Study 2

To assess whether momentary arousal or mind-sets explain the data better, we asked two groups of participants to read an eye chart before and after completing physical exercise. For the experimental group, this arousal was conjoined with a potentially vision-enhancing mind-set, whereas for the comparison group, it was not.

### Method

Thirty-two male college students were randomly divided into two groups and were instructed by an experimenter, who was blind to the hypothesis, that we were interested in the relationship between arousal and vision. Participants read a Snellen eye chart, exercised, and were then informed that we expected exercise to improve vision, so we would like them to do their best and read the eye chart again.

The exercise for the experimental group ($n = 16$) consisted of 15 jumping jacks (20 s of exercise). In contrast, participants in the comparison group ($n = 16$) were asked to skip around the room for 1 min. In pretesting, these two activities were found to be equivalent with respect to change in pulse rate from a resting position (the average pulse increase for people performing jumping jacks was 17.9 beats/min, whereas the average pulse increase for people skipping was 21.6 beats/min, $p > .1$); however, pretesting also showed that jumping jacks were considered more athletic than skipping (by 100% of 20 people asked). Assumptions about physical fitness often influence our assumptions regarding fitness of the senses. Moreover, athletes have been consistently found to have higher visual acuity than nonathletes (e.g., Christenson & Winkelstein, 1988; Stine, Arterburn, & Stern, 1982). This seems reasonable because vision enhances most forms of coordination, which is the basis of athletic ability. Out of 16 people we surveyed, 11 (69%) responded that athletes had better vision than nonathletes. To the extent that experimental participants were being athletes, and that their mind-sets linked athletes and good vision, vision should have improved.

### Results and discussion

The two groups did not differ in initial vision. The mean score was 20/14.58 for the jumping group and 20/16.25 for the skipping group ($p > .10$). Only 2 people had below-average vision (worse than 20/20), and both were in the skipping group. Only 6.25% (1 participant) of the skipping group improved from pretest to posttest, whereas 37.5% (6 participants) of the experimental group improved, $\chi^2(1, n = 32) = 4.57$, $p < .05$. The results of this experiment suggest that it was the mind-set regarding athleticism, rather than sheer exercise arousal, that influenced vision.

## Study 3

As Studies 1 and 2 demonstrate, mind-sets can influence visual acuity. This finding raised the more fundamental question of whether people know how well they can see. An understanding of one's visual acuity comes primarily from visits to optometrists, who test vision under circumstances that differ greatly from everyday life. In Study 3, we tested whether implicit expectations generated by mind-sets affect performance when arousal is held constant.

Study 3 used a within-participant design and included both women and men as participants. The mind-set tested was the rigid (but rational) belief that people are likely to see less well as they read progressively lower lines on an eye chart because letters get progressively smaller. We presented each participant with a classic eye chart, a reversed eye chart, and a shifted eye chart.

In the reversed eye chart, letters became progressively larger further down the chart. Thus, whereas the standard eye chart creates the expectation that soon one will not be able to see, the opposite is true for our reversed chart. Our hypothesis was that participants would see more letters from the reversed chart than from the classic chart.

We exploited the mind-set that most people can see the first several lines of the chart, and that problems seeing occur around two thirds of the way down the chart. Our shifted eye chart started at the line two thirds of the way down the standard Snellen eye chart so we could compare participants' performance when the same lines were presented at the top of the chart with their performance when the lines were in the bottom third of the chart. We expected that the letters at the top of the shifted chart would be seen better than letters of the same size on the classic Snellen chart, even though their size was small, just because they were at the top of the chart.

### Method

Twenty participants (7 women and 13 men) were ushered into a room, individually, and asked to read from each of three Snellen eye charts (one for each condition, in random order) from a distance of 10 ft. After reading the charts, participants were given a demographic questionnaire; they were also asked whether they thought vision could improve.

In the control condition, participants read a classic Snellen chart in which the letters got smaller on each successively lower line. In the reversed-chart condition, participants read a chart that was the reverse of the classic chart, so that from top to bottom, the letters got increasingly bigger. In the shifted-chart condition, participants read a version of the traditional Snellen chart that included the lines from the bottom third of the chart and was expanded with additional lines to make it look like a full Snellen chart. At the top, the shifted chart included letters equivalent to the medium-size letters on the normal eye chart and the chart progressed to letters of very small size at the bottom. Participants were presented with the charts for the three conditions in random order, to control for practice effects.

### Results and discussion

The results supported our hypothesis. At pretest, there were no significant differences in visual acuity between the groups. Participants accurately saw a significantly greater proportion of letters from the smallest line of the Snellen chart (comprising letters in font size 21) when it was presented in the reversed format ($M = .57$, $SD = .44$) rather than the traditional format ($M = .11$, $SD = .26$). Results of the matched $t$ test comparing the reversed and traditional charts were significant, $t(19) = -4.45$, $p < .001$. Participants also saw more letters on the next-to-smallest line (comprising letters in font size 33; line 8 in the traditional chart and line 2 in the reversed chart) in the reversed condition ($M = .77$, $SD = .37$) than in the control condition ($M = .59$, $SD = .43$), $t(19) = -2.90$, $p < .01$. Participants in these two conditions did not demonstrate differences in visual acuity for any other lines; we expected this result given that all participants could read these lines.

The results of the questionnaire showed that 11 participants believed vision could improve, 6 believed it could not, and 3 had no opinion. Post hoc $t$ tests revealed that participants who thought they could improve their vision showed significantly greater improvement (on the reversed vs. traditional test) than participants who did not think improvement was possible, but only for the next-to-smallest line, $t(15) = 2.29$, $p < .05$. This effect did not hold for the smallest line.

As predicted, a matched $t$ test comparing the shifted and traditional charts showed that participants read significantly more letters of font size 43 accurately when they were presented at the top of the chart (shifted condition; $M = .87$, $SD = .25$) than when they were in the bottom third of the chart (control condition; $M = .81$, $SD = .31$), $t(19) = -2.34$, $p < .05$.

## General Discussion

These studies support an earlier investigation that found that when older men were primed with mind-sets of their life as lived 20 years earlier, they looked younger and exhibited increased hand strength, joint flexibility, mental acuity, and visual performance (Langer, 1989, 2009). In the studies presented in this article, we found additional support for the hypothesis that altering mind-sets improves visual acuity. The fact that the mind-sets tested were unrelated to each other suggests the ubiquitous nature of the ability to overcome physical limits with psychological means. Interestingly, visual training programs in which people are given eye exercises to improve visual acuity may be effective because they prime the belief that exercise improves vision.

On a more general level, how does mindlessness affect visual acuity? In the case of mindless blindness, stimuli that are not goal related are not seen. In the case of habituation, even stimuli that are goal related can become invisible. It could be that visual habituation processes depend not only on the physical stability of objects, but also on the stability of their meaning. Most of the time, mind-sets imply habituation to visual stimuli—people literally stop seeing things that have constant meaning to them. Mindfulness, by contrast, creates novelty, and thus stimuli have different, continually emerging meanings. The mindful process of continual distinction making with regard to familiar stimuli prevents habituation and therefore prevents mindless blindness. It is experienced as engagement; thus, it is energy begetting, not consuming, and may create a more sustained level of arousal if not tied to a particular mind-set.

These studies suggest that vision is limited, at least in part, by mindlessness. Although our studies made positive use of mindlessness, far greater and sustained improvement is likely to follow from mindfulness. Mindfulness does not rely on a second person's intervention; it is self-generating and self-sustaining (see Langer, 1985, 1989, 1994, 2005, 2009). To take full advantage of mindfulness, however, one first has to question one's mindless beliefs about what is and is not possible.

### Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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