Corrigendum for "Optimal Expectations and Limited Medical Testing": Updated Figure 4

Oster, Shoulson & Dorsey

Update: Jan, 2016

Introduction and Overview

The purpose of this document is to update and correct Figure 4 from from "Optimal Expectations and Limited Medical Testing: Evidence from Huntington Disease." This figure documents how perceptions about the risk of HD evolve with symptoms. It compares these perceptions with the "actual risk" of HD based on a Bayesian updating calculation described in the paper.

The construction of Figure 4 is correctly described in the text of the paper and the data on perceptions are documented correctly. However, the construction of the "actual risk" series is not accurate. There are two central issues. First, there were data limitations at the time of publication which have since been relaxed and the better data now available changes the picture. Second, there was an error in the construction of Figure 4 which should have been recognized at the time.

We detail the issues here and include the corrected figure. The original figure showed evidence of over-optimism at all levels of motor score. The corrected figure shows that for low symptom levels individuals are correct about their risk level, whereas those with more advanced symptoms are overly optimistic. Overall, the levels of over-optimism are lower than documented originally. We will briefly discuss the implications for the theory at the end of this document.

Details of Update to Figure 4

Figure 4, as with the rest of the paper, uses the PHAROS data. These data contain 1001 individuals who enter the sample at 50% risk of HD. They are followed over time, for up to 10 years, with visits approximately every 9 months. At each visit the individuals undergo an evaluation for HD symptoms and at some visits they are asked about their perceived risk of HD. These are the data that are used to construct Figure 4.

The ideal way to construct the true risk in Figure 4 would be to report the actual share of individuals in the PHAROS data with the HD mutation by motor score and graph that series along with the perceived risk. Individuals in the PHAROS study were tested for HD as part of the study, but at the time of the publication of the original paper these data were not accessible to researchers in any form. As an alternative, we used a Bayesian updating procedure which took a baseline risk of HD and updated based on the propensity to have a given motor score for individuals with and without the HD mutation.[1] The ideal data to use for this would have been the motor score evaluation from the PHAROS individuals themselves. However, because we could not access the data on HD mutation in this sample, we were not able to observe which individuals in PHAROS did or did not carry the HD mutation. As a result, we instead compared a hypothetical individual with HD symptoms to individuals who were not at HD risk but were tested as part of a second study, called the COHORT study. These not-at-risk individuals were typically spouses of individuals with HD. This procedure is detailed in the paper.

Subsequent to the publication of the paper, limited access to the PHAROS gene testing data has become available. Due to concerns about revealing gene status to participants it is still not possible to construct the ideal figure with true and perceived status from the data. However, we were able to utilize the testing data to address the second issue above. Specifically, we are now able to compare PHAROS individuals with and without the HD mutation and do a more accurate version of the Baysian updating. This gets closer

[1] This relies on the fact that low levels of motor symptoms are often documented even for individuals without the HD mutation, due to natural variation in performance on these test.

to the concept of interest: if someone who is at risk is observed to have a motor score of X at a particular time, what is the chance they carry the HD mutation? We have produced a clinical paper (Oster et al, 2015) which uses these data to generate predicted HD risk given age and motor score.

In addition to this data change, we became aware of an error in the construction of Figure 4. When we constructed Figure 4, we assumed that the baseline probability of HD was 50%, regardless of individual age. This is not correct. We should have taken into account that as individuals age without HD diagnosis their baseline probability declines. Put simply, among a population of 100 at-risk individuals who reach age 50 without a diagnosis of HD, fewer than 50 of them will carry the HD mutation. That it was necessary to adjust for this should have been obvious to us and we regret the error.

Using the newly available data on gene status in PHAROS, combined with estimates on baseline HD probabilities by age, we constructed a true posterior risk of HD by age and motor score. This analysis has recently been published (Oster et al, 2015) and the procedure is detailed there. It is a fairly straightforward example of Bayesian updating. . We use these new data in combination with the PHAROS data to recreate Figure 4.

The updated Figure 4 is below (as Figure 1). As noted in the introduction, there is much less over-optimism here. Individuals with low symptom levels are if anything slightly pessimistic although these differences are small. The over-optimism remains strong for those with more advanced symptoms.

It is useful to note that most of the change between the original Figure 4 and the update is due to the new data. Figure 2 below re-creates Figure 4 with the (incorrect) assumption of a 50% risk for the baseline HD risk. The actual risks are higher than in the fully corrected figure but the difference between the two is relatively minor.

Intuitively, the change relative to the figure in the paper reflects the fact that in the updated data low levels of motor scores are not very informative about disease. A motor score of "1" appears approximately as frequently among PHAROS participants who do not carry the HD mutation as those who do. The true risk given this symptom level is therefore just the baseline risk of HD, which is below 50% given the adjustments for age. The data on which these calculations were based in the original paper over-estimated how often HD-positive individuals would appear with a low score and under-estimated how often those without the HD mutation would appear with this score.

Implications for Theory

The theory in the paper explains over-optimism by assuming people can adopt biased beliefs about their disease state, which then constrain their actions. The model therefore takes as a primitive that at least some people will choose to hold incorrect beliefs. The implications for testing behavior (testing increasing in risk, for example) rely on the fact that even as symptoms develop individuals continue to believe and act as if they do not carry the HD mutation. This remains true in the updated figure; at higher symptom levels beliefs are clearly over-optimistic. What the new figure makes clear is that for people with very limited symptoms beliefs are approximately correct and are not overly optimistic. To a large extent the interesting action in the data - the increase of testing with risk, the consistency of action choices, the biased beliefs - occurs among individuals with significant symptoms. The theory continues to fit the behavior of these individuals.

Conclusion

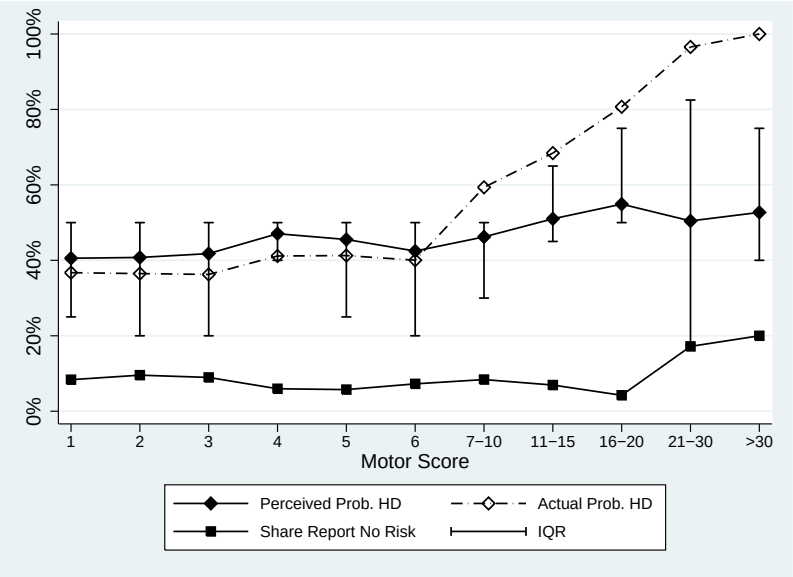
This document provides an updated and corrected version of Figure 4 in our paper, "Optimal Expectations and Limited Medical Testing." The update is a result of two changes. First, subsequent to the publication of the paper it became possible to access genetic testing data from the sample which we used for our analysis. When we preform calculations with the updated data, the results in the Figure change. Second, we became aware of an error in the construction of Figure 4, in which we did not update the baseline probability of HD to address changes as people age. We deeply regret this error. The updated Figure demonstrates less over-optimism at low symptom levels, although continues to show evidence of over-optimism as individuals develop symptoms of HD.

References

Oster E, Eberly SW, Dorsey ER, Kayson-rubin E, Oakes D, Shoulson I. Informativeness of Early Huntington Disease Signs about Gene Status. J Huntingtons Dis. 2015;4(3):271-7.

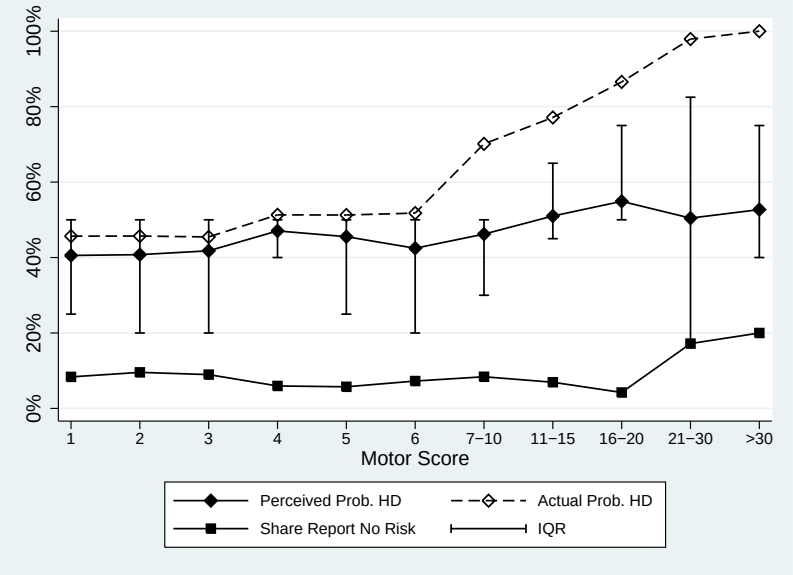
Figures

Figure 1: Updated Figure 4



Notes: This figure is a fully corrected version of Figure 4.

Figure 2: Updated Figure 4, Assuming Baseline 50% Risk



Notes: This figure is a version of Figure 4 which uses the new data but retains the (incorrect) assumption that the baseline risk is 50% regardless of age.