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Why IQ Test Scores are Slightly Decreasing: Possible System-Based Explanation for the Reversed Flynn Effect

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Abstract

Researchers who monitor the average intelligence of human population have reasonably recently made an unexpected observation: that after many decades in which this level was constantly growing (this is known as the Flynn effect), at present, this level has started decreasing again. In this paper, we show that this reversed Flynn effect can be, in principle, explained in general system-based terms: namely, it is similar to the fact that a control system usually overshoots before stabilizing at the desired level. A similar idea may explain another unexpected observation – that the Universe's expansion rate, which was supposed to be decreasing, is actually increasing.

Keywords: IQ scores, Flynn effect, reversed Flynn effect, system-based approach, cosmology

1 Formulation of the Problem

IQ tests: a brief reminder. For many decades, researchers have been using standardized test to measure Intelligent Quotient (IQ, for short), a numerical value that describes how smarter is a person that an average population:

- the IQ value of 100 means that this person has average intelligence,
- values above 100 means that this person's intelligence is above average, and
- values below 100 means that this person's intelligence is below average.

Of course, this is a rough estimation. Researchers have known that there are different types of intelligence, and that it is therefore not possible to adequately characterize one person's intelligence by using a single number. However, the IQ test score remains a reasonable overall (approximate) measure both of the individual intelligence and of the relative intelligence of different population groups. For example, a recent study showed that non-violent criminals are, on average, smarter than violent ones; this makes sense, since it takes some intelligence (ill-used but still intelligence) to steal without using violence.

Average IQ scores grow: Flynn's effect. Since the IQ scores describe the relation of a tested person's intelligence to an average intelligence at the given moment of time, researchers periodically estimate this average level of intelligence.

Somewhat unexpectedly, it turned out that for almost 100 years, the average level of intelligence has been growing; see, e.g., [2, 4, 5, 8, 9, 11, 15, 18, 23]. Specifically:

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- if we give average current folks the test from the 1930s, they will, on average, score way above 100, and
- vice versa, if we measure the intelligence of the 1930s folks in a current scale, their average intelligence will be way below 100, at about the 80–90 level.

This steady increase in intelligence is known as the *Flynn effect*, after a scientist who actively promoted this idea.

Why IQ scores grow: possible explanation. There are many explanations for the growth in intelligence. One of the natural ones is that, in contrast the old days, when in many professions, physical force was all that is needed to earn a living, nowadays intelligence is very important – non-intelligent jobs have been mostly taken up by machines. No one needs a galley slave to row a boat, no one needs a strong man to lift heavy things, etc. It is therefore reasonable that modern life requires more intelligent activities, and this increase in solving intelligent problems naturally leads to an increased intelligence – just like exercising the muscles leads to an improved physique.

Reverse Flynn effect. While the intelligence scores have been steadily rising for several decades, lately, a reverse phenomenon has been observed, when the average scores no longer grow; instead, they decline. This decline is not as big as to wipe out the results of the previous decades of growth, but it is big enough to be statistically significant; see, e.g., [1, 6, 7, 10, 13, 14, 16, 17, 19, 20].

How can we explain the reverse Flynn effect? There are many different explanations for the reverse Flynn effect: that it has been caused by pollution, that it has been caused by declining education standards, etc.

In this paper, we analyze this phenomenon from the general systems viewpoint, and conclude that, from the system's viewpoint, a current small decline is natural – and that we therefore do not need to be unnecessarily alarmed by this decline. In other words, in spite of this decline, it is still reasonable to remain optimistic.

2 Systems-Based Analysis of the Problem and the Resulting Explanation of the Reversed Flynn Effect

Current explanation of the Flynn's effect reformulated in general terms. The current explanation of the Flynn's effect is that the increase in intelligence is motivated by the fact that nowadays, more and more important real-world activities require intelligence.

In other words, the previous level of intelligence – which worked optimally in the past – is no longer optimal for adequate functioning in the modern world. Thus, it is necessary to raise the average intelligence to a new higher level, a level that would guarantee effective functioning in this world.

Why general systems approach is necessary. Changing intelligence is not something we directly know how to do. It is a complex process that, probably, involves many different related quantities. The corresponding change in the values of these quantities $x_1, \ldots, x_n$ can be described by an appropriate system of differential equations

$$\frac{dx_i(t)}{dt} = f_i(x_1(t), \cdots, x_n(t)). \tag{1}$$

These changes are slow: they are statistically significant and impressive when we compare 1930s with 1990s, but not that noticeable year after year. Suffice it to say that the reversed Flynn effect was not noticed until a decade or so passed when, as it turned out, the intelligence scores were declining. The fact that these changes are slow means that with the passage of time, the values x_i of the corresponding quantities change very little. Let us pick some moment of time t_0. Then, the corresponding differences $\Delta x_i(t) \stackrel{\text{def}}{=} x_i(t) - x_i(t_0)$ are small. Thus, we substitute the expressions $x_i(t) = x_i(t_0) + \Delta x_i(t)$ into the right-hand side of the formula (1), expand this right-hand side in Taylor series and keep only linear terms in this expansion. Thus, for the new variables $\Delta x_i(t)$ for which, by the way,

$$\frac{d\Delta x_i(t)}{dt} = \frac{dx_i(t)}{dt},$$

we get a system of linear equations with constant coefficients:

$$\frac{d\Delta x_i(t)}{dt} = c_i + \sum_j c_{ij} \cdot \Delta x_j(t),$$

for appropriate coefficients c_i and c_{ij}.

The general solution to such systems of equations is well known, it depends on the eigenvalues $\lambda = a + b \cdot \mathrm{i}$ of the corresponding matrix c_{ij}, and, in general, contains not only exponential decrease of the difference between the current and the limit state, but also oscillations (corresponding to $b \neq 0$).

This is known phenomenon in control: in an answer to a perturbation, a stable system usually not just monotonically returns to the original state, it often goes through kind of oscillations: first, it overshoots the original state, then the value goes down and we get an undershoot – a smaller one than the original overshoot – then we may get one more overshoot, etc.

How this explains the reversed Flynn effect. In general, when a dynamical system tries to reach a certain level, it usually does not reach this level monotonically. It first overshoots, then undershoots, then may overshoot again, etc. In each such cycle, the deviation between the current and desired values decreases – and eventually, the system stabilizes at this new level.

This is exactly what we observe with the dynamics of average intelligence scores: first, we have a large increase, then a slight decreases. From this viewpoint, we can say that the current slight decrease does not necessarily mean that the population is becoming dumber. There is no need to be pessimistic about the future of mankind. This decline simply means that the natural dynamic phenomena that led to the original increase overshot (as is natural for dynamical systems). Our prediction is thus that this decline will continue to be small, and the resulting average intelligence level will still be higher as in the distance past. After that, we may see another – even smaller – increase, then maybe again decrease, etc.

3 Maybe the Same Idea can Explain the Observed Increase in Universe's Expansion Rate: A Speculative Observation

Phenomenon. It is known that, according to modern physics, the Universe expands; see, e.g., [22]. Until the late 1990s, it was assumed that – in accordance with simple physical models – this expansion occurs at a decreasing rate. However, later observations showed that while this rate may have been indeed decreasing in the past, it is, at present, somewhat increasing; see, e.g., [12, 24]. This phenomenon even won the Nobel Prize in Physics.

Possible system-based explanation. There are many different physical explanation for this phenomenon, e.g., many explanations involving dark matter – to be more precise, using different differential equations describing the dynamics of the mysterious dark matter.

In this case, while in the cosmological time of billions of years, changes are great, year-by-year (and even million years by million years) changes are very small in comparison. Thus, similar to the IQ case, we can use linearization to analyze this phenomenon.

Our above analysis shows that there may be a general system-based explanation for this phenomenon. Namely, in general, on top of the systematic change, we usually have oscillations. Because of these oscillations, even when in the systematic component, accelerations decrease, added oscillation may make it increase or decrease all the time – and this may be a general system-based explanation for the observed phenomenon.

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