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International Journal of Education and Psychological Research (IJEPR) Volume 7, Issue 3, September 2018
Print - ISSN: 2349 - 0853, e-ISSN: 2279 - 0179 Available online at www.ijepr.org
Orignal Research Article Open Access

Accepting Lies Through the Tunnel Effect; An Analogy Between Physics and Psychology

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Abstract:

Explaining how some individuals are able to accept a lie as the truth, even when there is overwhelming proof that it is, in fact, a lie, is a difficult task that encompasses a series of complex interactions between several psychological phenomena. This paper introduces a way to explain such irrational behavior, by drawing an analogy with the tunnel effect, an illogical phenomenon of physics whereby a fundamental particle can pass through a barrier and be transmitted even when it does not have enough energy to do so. Through this analogy, a better understanding of the underlying reasons for such behavior is achieved, linking specific psychological variables to the physical variables depicting the transmission of a wave in the framework of Schrödinger's stationary wave equation.

Key words.: *lie, truth, confirmation bias, tunnel effect, quantum mechanics, behavior.*

Article History: *Received: 01st August 2018, Revised: 01st September 2018, Accepted: 09th September 2018, Published: 30th September 2018.*

I. INTRODUCTION

Explaining (apparently) irrational behavior in psychology, economics and education is always a complex task for professors but, as Shannon (1991) suggests, the employment of certain analogies related to other branches of science, such as physics, may help students to better understand the underlying reasons for such behavior, opening up avenues for new insights, and serving as a possible critique of the representational theory of mind.

One such analogy helps to explain how some individuals may accept a lie as the truth, even when there is proof that it is, in fact, a lie. Examples include voting behavior in favor of a corrupt politician, or purchasing behavior in favor of a deceitful company. For example, after the Volkswagen emissions scandal of 2015, also known as 'Dieselgate', the German carmaker actually reported an increase in sales and profits (Pastrana, 2016). Volkswagen tried to deceive people into believing that the chief executives at the company were unaware of the problem, and claimed that a few rogue engineers were responsible, as Michael Horn, CEO of the American division of VW asserted shortly after the scandal broke. This was proved to be false, and the company is still being investigated for several irregularities affecting other brands of the corporation, such as Porsche. The company was lying because it was saying something that it knew to be false with the intention of deceiving the general public (Fallis, 2009), but, nevertheless, sales increased in the following months.

Cognitive bias explains why some individuals give more weight to information that is consistent with their preexisting beliefs and prejudices (Del Vicario et al., 2016), but it could be insufficient to explain why certain individuals, once shown the truth, continue to believe the lie, and behave accordingly.

In this short article, I introduce a way to explain such irrational behavior, by drawing an analogy with an illogical phenomenon of physics, known as the tunnel effect. Quantum mechanics has empirically proven that, under certain circumstances, a fundamental particle can pass through a barrier and be transmitted even when it does not have enough energy to do so. I postulate that a brief description of this physics phenomenon may help to understand some of the psychological variables that could be considered in order to explain the social phenomenon of accepting lies even when the truth is known.

II. THE TUNNEL EFFECT

Following Tipler & Mosca (2007), we may depict the Schrödinger equation for a stationary wave as (1):

$$\frac{-\hbar^2}{2m}\frac{d^2\Psi(x)}{dx^2} + U(x)\,\Psi(x) = \mathrm{E}\Psi\,(x) \qquad (1)$$

where $U(x)$ is the potential energy, E is the total energy of the particle, $\hbar$ is the reduced Planck constant, m the mass of the particle and $\Psi(x)$ is the wave function. $U(x)$ is essential for this illustration because it represents the interaction with the environment, and the solution of the equation depends on its value and its relationship with the total energy E. The square of the wave function reflects the probability of finding the particle in the space x. Therefore, the energies that solve (1) must satisfy the normalization condition (2):

$$\int_{-\infty}^{\infty} |\Psi_n|^2\, dx = 1 \qquad (2)$$

If we consider a particle with energy E in a space region where there exists a potential barrier U_0 in the following form (3),

$$U(x)\begin{cases} 0 & x < 0 \\ U_0 & x > 0 \end{cases} \qquad (3)$$

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then, as this particle has an associated wave function, there will be a probability of reflection and a probability of transmission when it encounters the potential barrier. Such probabilities depend on the relationship between E and $U(x)$. When $E < U_0$ the probability of reflection is maximized, although the wave may penetrate the region $x>0$.

However, when $E>U_0$ the probability of reflection can be calculated as (4):

$$R = \frac{(k_1 - k_2)^2}{(k_1 + k_2)^2} \quad (4)$$

where k_1 is the wave number of the incident wave, and k_2 is the wave number of the transmitted wave. The probability of transmission is T=1-R.

If we now consider that the potential barrier has a finite width a, then the potential barrier is expressed as (5):

$$U(x)\begin{cases} 0 & x < 0 \\ U_0\ 0 & < x < a \\ 0 & x > a \end{cases} \quad (5)$$

When $E<U_0$ there is a probability of reflection but also a probability of transmission; the wave (particle) may cross the barrier and continue with less amplitude. The probability of transmission is, in this case (6):

$$T = e^{-2\alpha a} \quad when\ aa>>1 \quad (6)$$

being α (7):

$$\alpha^2 = \frac{2m(U_0 - E)}{\hbar^2} \quad (7)$$

Therefore, the probability of penetration through the barrier decreases exponentially with the width, as well as with the square root of the relative height (U_0 - E), of the barrier. In addition, the mass of the particle also plays a fundamental role, because larger particles are less likely to be transmitted.

III. THE ANALOGY WITH THE PSYCHOLOGICAL (MENTAL) POTENTIAL BARRIER

We could say that everyone has a mental potential barrier, and that incoming messages interact with this obstacle and are assimilated (transmitted) or not assimilated (reflected) by individuals, depending on the nature of the message. The mental potential barrier represents the human capacity to discern truth from lies.

If we consider the mass of a particle as an analogy of distrust towards the characteristics of an incoming message, then we could say that, to the extent that the distrust increases, the probability of transmission decreases (e.g. Gold, 2002; Dyck, Perason-Merkowitz & Coates, 2018), i.e. it is less likely that the message will cross the mental barrier and be assimilated in its original form. In addition, the height of the barrier U_0 depends on how susceptible individuals are to confirmation bias. To the extent that confirmation bias increases, the height of the barrier diminishes, because individuals will be less able to ascertain what is really true; they will be slaves to their own beliefs.

However, when the message comes from a trustworthy source, although its "energy" may be insufficient to cross the mental barrier, the probability of transmission (assimilation) increases. It is possible that the intensity of the message is lower (the physical amplitude of the wave is reduced), but the features of the original message remain. Therefore, although people know that the message is a lie, and they are able to identify it as being a lie, there exists a higher chance that the message will be assimilated as being true, as it comes from a more trustworthy and credible source.

The width of the barrier could be related to the experiential, educational and cultural characteristics of each person. It is expected that individuals with a higher level of such characteristics will possess a wider barrier, because they will be less prone to assimilating fake news, and to being manipulated by the creators of incomplete and deceitful information.

Repetition plays a major role in the assimilation of messages, because it means that the same particle, or others with non-equal but similar mass, are continuously interacting with the barrier. Therefore, to the extent that interaction increases, the probability of assimilation also increases, thereby proving that the saying “A lie told often enough becomes the truth” also applies in this analogy.

In addition, repetition increases fluency, or the capability of information processing and memory retrieval. Therefore, messages that were assimilated in the past would be more easily retrieved if they are familiar.

IV. FURTHER TESTING

I summarize the main terms employed in the analogy in Table 1, considering the case of $E<U_0$, i.e. when the message is not able to overcome the barrier, but there is a probability of transmission.

Table 1: Main terms for the tunnel effect analogy

Physics	Psychology
Potential barrier (obstacle to transmission)	Mental barrier (obstacle to accept a message as true)
Fundamental particles (waves)	Messages (all types of communications)
Mass of the incident particles (*m*) (+)	Distrust about the received message *(z1)* (+)
Height of the potential barrier (U_0) (+)	Relevance of the confirmation bias *(z2)* (-)
Amplitude of the wave	Intensity of the message
Width of the barrier *(a)* (+)	Experiential, educational and cultural characteristics of the receptor *(z3)* (+)
Ongoing interaction with the barrier	Repetition of messages *(z4)*
Probability of transmission *(T)* (+)	Probability of accepting the message as being false *(z5)* (+)

(+) and (-) represent the direction of association between the physical variable and the psychological variable. If both variables are (+) they are positively correlated, but if one is (+) and the other is (-) they are inversely correlated.

This analogy could be used in further studies to test the model implied by the mentioned relationships. For example, the set of equations could be represented with a functional non-linear relationship as follows (8):

$$z5 = f(z1, z2, z3, z4, u) \quad (8)$$

where u represents the white noise of other variables not taken into consideration.

This analogy may be extended even further. For example, the height of the potential barrier has been identified as the relevance of the confirmation bias, but it may also encompass the susceptibility to the attraction principle of social influence (see Goldstein, Martin & Cialdini, 2009). The attraction principle explains our preference for beauty, for those individuals who share common features with ourselves, or for those with whom we have affective ties (Christakis & Fowler, 2014; Jarymowicz, M., 2015; Kramer & Block, 2011). Therefore, the beauty and similarity to ourselves of those individuals who convey a message may affect the probability of transmission.

Sometimes, there is a twilight zone between veracity and lying. For example, some companies may occult or distort information for motives related to ethical dilemmas (Thummers, 2017). In such cases, individuals may sympathize with the behavior of the companies, and attempt to justify their fraudulent behavior. However, in this paper we do not consider such situations, but rather those cases where companies (or other sources of information) know perfectly well that they are lying in order to manipulate the perception and behavior of those who receive this information.

V. CONCLUDING REMARKS

Irrationality is an inherent characteristic of human behavior, but sometimes we are surprised when we find that people accept totally fallacious ideas, even when they are aware of doing so, or at least have well-founded suspicions.

By drawing an analogy with the tunnel effect, one of the most curious events of quantum mechanics, we have argued that it is possible to postulate an explanation for this phenomenon based on fundamental concepts of physics. This analogy is useful to better understand the complexity of this research framework: the interaction between the deceptive behavior of individuals and organizations, principles of social influence, and the assimilation of information by the receptors of these messages

VI. ACKNOWLEDGEMENTS

Author acknowledges the financial support from project ECO2015-65637-P (MINECO/FEDER). This study is the result of the activity carried out under the program Groups of Excellence of the region of Murcia, the Fundación Séneca, Science and Technology Agency of the region of Murcia project 19884/GERM/15.

VII. REFERENCES

- Christakis, N. A. & Fowler, J. H. (2014). Friendship and natural selection. *PNAS*, 111, 10796-10801.
- Del Vicario, M., Scala, A., Caldarelli, G., Stanley, H. E. & Quattrociocchi, W. (2016). Modeling confirmation bias and polarization. *Scientific Reports,* 7, doi: 10.1038/srep40391
- Dyck, J. J., Pearson-Merkowitz, S. & Coates, M. (2018). Primary Distrust: Political Distrust and Support for the Insurgent Candidacies of Donald Trump and Bernie Sanders in the 2016 Primary. *Political Science and Politics,* 51 (2), 351-357.
- Fallis, D. (2009). What is lyingΨ *The Journal of Philosophy*, 106 (1), 29-56.
- Gold, S. D. (2002). Trust, distrust and trustworthiness. *Journal of General Internal Medicine,* 17 (1), 79-81.
- Goldstein, N. J., Martin, S. J. & Cialdini, R. B. (2009). Yes! 50 scientifically proven ways to be persuasive. Pocket Books.
- Jarymowicz, M. (2015). Mental Barriers and Links Connecting People of Different Cultures: Experiential vs. Conceptual Bases of Different Types of the WE-Concepts. *Frontiers in Psychology,* 6, 1950.
- Kramer, T. & Block, T. (2011). Nonconscious effects of peculiar beliefs on consumer psychology and choice. *Journal of Consumer Psychology,* 21, 101-111.
- Pastrana, E. (2016, February 2). España "pasa" del fraude: Volkswagen vende un 30% más en enero a pesar del 'Dieselgate' . Retrieved from: https://www.elconfidencial.com/consumo/2016-02-09/la-sorpresa-de-volkswagen-el-escandalo-no-frena-las-ventas-del-gigante-aleman_1149472/
- Shannon, B. (1991). Cognitive psychology and modern physics: Some analogies. *European Journal of Cognitive Psychology* 3 (2), 201-234
- Thummes, K. (2017). In the Twilight Zone Between Veracity and Lying: A Survey on the Perceived Legitimacy of Corporate Deception in Reaction to Ethical Dilemmas. *International Journal of Strategic Communication*, doi:10.1080/1553118X.2017.1385463
- Tipler, P. A. & Mosca, G. P. (2007). *Physics for Scientists and Engineers.* W. H. Freeman; 6th edition edition