

*MEASLES MUMPS AND RUBELLA VACCINATION AND AUTISM: MISPERCEPTION/MISCOMMUNICATION VS. SCIENTIFIC EVIDENCE. RESULTS OF A BLINDED ANONYMOUS ITALIAN SURVEY*

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**Abstract.** Herd immunity towards measles, one of the 20 most lethal diseases in human history, has been recently challenged on a global scale. Despite a missing causal relationship, vaccine fear has triggered a global anti vaccine movement. We investigated i) the extent of the vaccination-autism false belief in a selected Italian population from two geographical areas with and without an ongoing epidemics for a potentially vaccination-preventable infectious disease (*Neisseria meningitidis*, groups C and B); ii) the corresponding information source; and iii) the belief in a possible global conspiracy. Four different population sub-categories (I-general population; II-parents of autistic children; III-paramedics; IV-physicians, biologists and pharmacists; n=424) were administered anonymous questionnaires. A total of 30.1% of the general population and the 54.5% of autism parents participants believed in a vaccine-autism relationship ( $P<0.0001$ ). The web was the major information source for the general population (35.3%). A total of 41.6% of the general population believes in a cover up of potential conflicts of interests by the Institutions. The belief in the autism-vaccination link was also positively related to the parenthood of an autistic child (OR:5.78, 95% CI: 2.36 to 14.12). We conclude that, against scientific evidence, information source and emotional involvement are major influencers of the misperception in the vaccine-autism paradigm, potentially fuelling the resurgence of vaccine-preventable diseases with major public health consequences.

**Key words:** autism spectrum disorders; global anti vaccine movement; information processing; public opinion survey; vaccination.

## INTRODUCTION

Vaccines represent a major improvement in mankind's health. Since the early 20<sup>th</sup> century, life expectancy has increased rapidly due to the advanced medical knowledge, which allowed disease prevention, thus improving lifestyle and early diagnosis. In particular, epidemics due to infectious diseases have been prevented and a large number of deaths avoided. Some of the infectious diseases, which put the fear of God into ancient population, are nowadays considered as harmless due to the vaccination practice. Would the immunization routine be stopped, the now contained infection diseases would come back to become a lethal injury. Despite all these rational concepts, in recent years herd immunity towards measles, one of the 20 most lethal diseases in human history, has been challenged on a global scale due to declining confidence in vaccination. In particular, in 1998, a causative role of the measles mumps and rubella (MMR) vaccination for autism spectrum disorders (ASD) has been speculated in an authoritative scientific journal [1]. The paper was subsequently retracted (2010) [1].

The temporal association between the vaccination against measles, mumps, and rubella and the onset of some neuropsychiatric disorders, including ASD, gave a boost to several studies, which were not able to prove a causal role of antecedent vaccinations [2]. Meta-analysis of case-control, cohort studies and epidemiological investigations, discredited the association between vaccines and ASD [3,4].

Although the rapid increase in the diagnosed cases of ASD might contribute to speculations on the parallel increase in the vaccination practice, a causal relationship between vaccine and ASD has not been supported by scientific evidences [5].

Besides the protection against pathogens, the immune response is also involved in brain development. To this regard, T-cell populations are essential for hippocampal neurogenesis, and innate immune mechanisms, together with the adaptive ones involved in regulation of cognitive functions [6]. Based on this knowledge, the induced-activation of immune response in the age of major neurological development have contributed to the raise of criticisms. A maternal immune activation during ges-

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tation, potentially dangerous for the foetal brain development contributes to the raise of such worries.

Overall, vaccine fears has triggered a global anti vaccine movement, fuelling the resurgence of vaccine-preventable diseases. Therefore, the vaccine-autism paradigm represents an ideal example of a prejudice stemming from collective imagination against scientific evidence, with major public health consequences for the whole community. The aim of the present study was to investigate i) the extent of the vaccination-autism false belief in an Italian population, ii) the information sources on which it is based, and iii) the belief in a possible conspiracy by public information media.

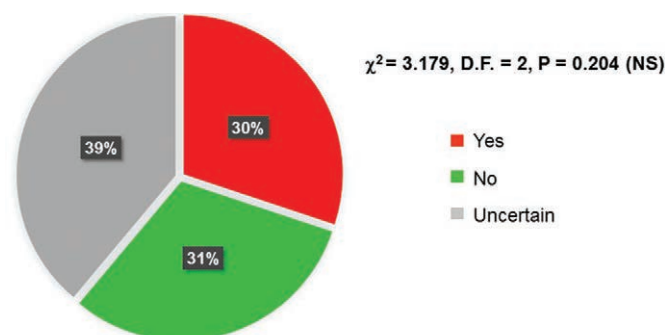
## MATERIALS AND METHODS

A total of 424 anonymous questionnaires with 3 major questions (open to comments), were administered to 4 different population sub-categories (I-General population; II-Parents of autistic children; III-Paramedics; IV-Physicians, biologists and pharmacists) from two geographical areas of Italy (Tuscany: Siena and neighbouring Val d'Elsa; Emilia Romagna: Marano sul Panaro), *i.e.*, with and without an ongoing epidemics for a potentially vaccination-preventable infectious disease (*Neisseria meningitidis*, groups C and B). The first question investigated was the degree of belief in the vaccine-autism relationship with a 5-scores Likert-type symmetrical scoring scale (single answers only): A) very much, B) possible, C) do not know, D) little, and E) do not believe. The 2<sup>nd</sup> question investigated on the information sources (multiple answers allowed): A) web, B) television, C) friends and acquaintances, D) autism parental and advocacy organizations, E) newspapers, F) family physician or paediatrician, G) scientific journals, H) others). The third question investigated on the opinion on the public information media (multiple answers allowed): A) correct, B) covering up potential conflicts of interests, C) under evaluating, D) over evaluating, E) misleading. Age, gender, and job were the only personal information requested to be disclosed by the participants. In order to identify possible predictor variables of the vaccine-autism belief, a stepwise multivariate logistic analysis was performed. A two-tailed P value of less than 0.05 was considered as statistically significant. The statistical software MedCalc v12.1.4 software package (MedCalc Software, Mariakerke, Belgium) was used.

## RESULTS

The *a priori* rejection rate was of 20.7% (88/424), with a total of 336 filled questionnaires (M: 121; F: 215, mean age, M±SD: 45.1±10.2, range: 23-84; Tuscany, n=

135; Emilia-Romagna, n=201). A total of 30.1% of the participants declared to believe (1<sup>st</sup> question, answers A-B), 38.9% were uncertain (answer C), and 31% did not believe (answers D-E) in the vaccination-autism link (Figure 1). The percentage of participants who declared to be uncertain or do not believe in the link was significantly higher in non epidemic area for potentially vaccination-preventable infectious disease as compared to the control area (Figure 2). In contrast, 54.5% of the autism parents, 17.6% of paramedics and 13.5% of physicians/biologists/pharmacists believed in the MMR vaccination-autism association ( $P<0.0001$ ) (Figure 3). Main information sources for the general population were found to be the web and newspapers, followed by TV, family physicians/paediatricians and friends/acquaintances. In particular, scientific journals were a quite infrequent information source (1%), (Figure 4). Information source appears to be dependent on population sub-categories (Figure 4). A total of 41.6% of the general population believed in a cover up of potential conflicts of interests, with 26% believing that information media underestimate the issue *vs* only 14.3% trusting them for correct information (Figure 5). The results of stepwise multivariate logistic analyses indicates that belief to the autism-vaccination link was positively related to the parenthood of an autistic child (OR: 5.78, 95% CI: 2.36 to 14.12); main information source from web (OR: 2.3, 95% C.I.: 1.37 to 3.88) or friends/acquaintances (OR: 3.87, 95% CI: 2.11 to 7.08); geographic area without ongoing epidemics for a potentially vaccination-preventable disease (OR: 2.40, 95% CI: 1.29-4.47); and female gender (OR: 1.97, 95% CI: 1.13 to 3.42). The belief in a conspiracy cover up by general media was positively related to searching information on the web (OR: 2.46, 95% CI: 1.51 to 4.01), TV (OR: 2.04, 95% CI: 1.22 to 3.40) and the non-epidemic area of provenience (OR: 1.74, 95% CI: 1.06 to 2.84). Interestingly, belief in conspiracy was inversely related to information accessed on newspapers (OR: 0.38, 95% CI: 0.19 to 0.76).



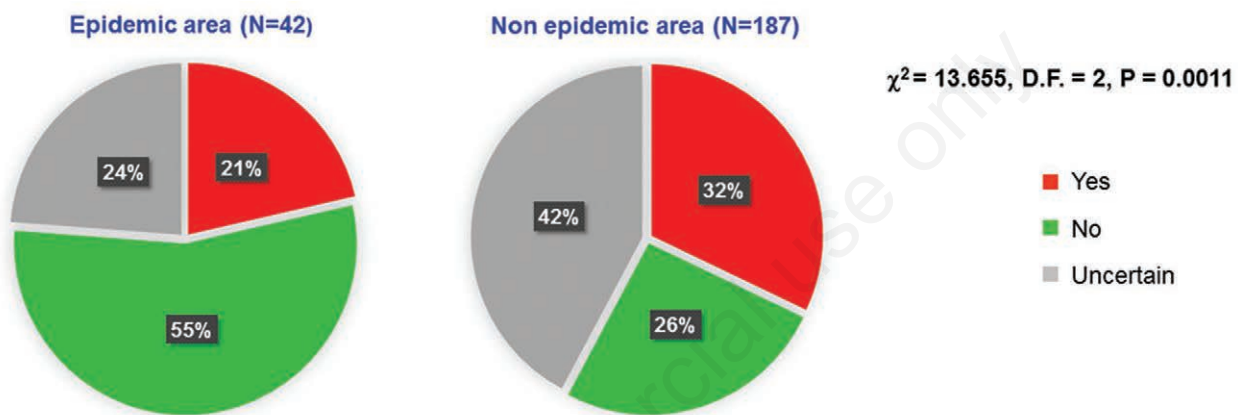
**Figure 1.** Belief in the autism-vaccination paradigm (N=424 administered questionnaires; N=229 filled questionnaires).

**DISCUSSION**

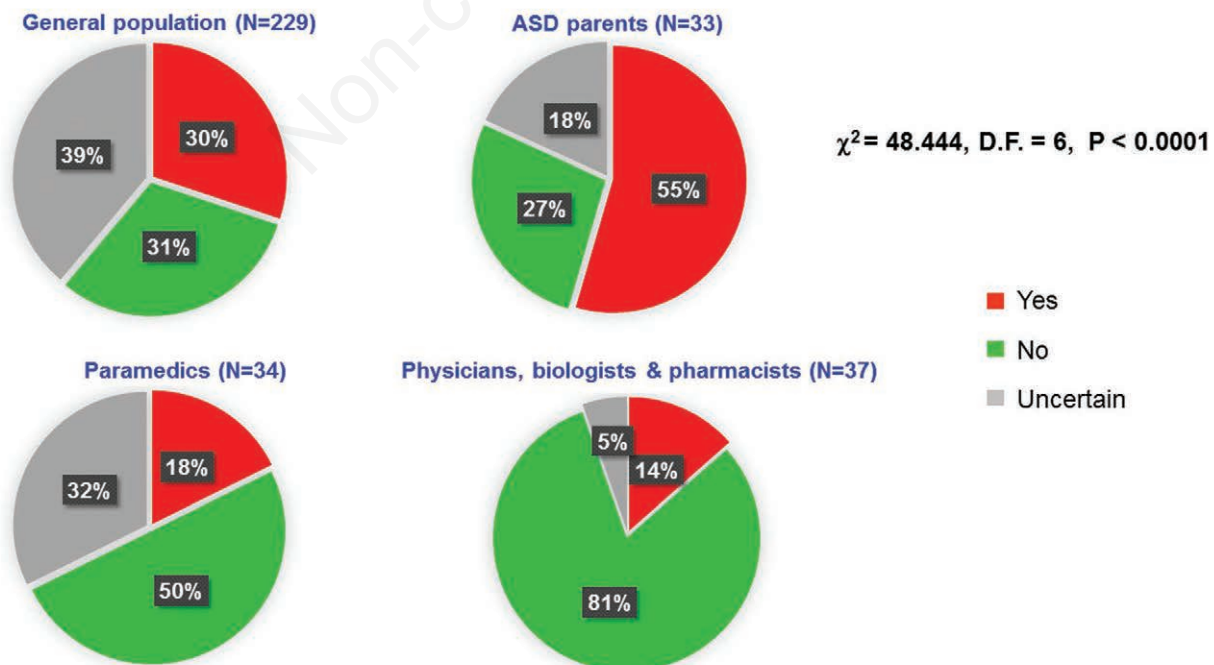
The main purpose of this study was to investigate on the extent of the vaccination-autism false belief and try to understand the possible reasons for its spread in the public opinion. This issue is of paramount importance with tangible and measurable effects in terms of community health [7,8]. In particular, according to the Italian Ministry of Health, over 230% increase of measles cases in Italy is reported, with a 2015 measles vaccine coverage at 24 months of life of 85.3% (range 68 to

92.3%), that is well below the 95% herd immunity target needed to block virus circulation in the entire community [9].

Our study shows that about one third of the participants believe in the false vaccine-autism paradigm, coupled with more than one third of people harbouring uncertain opinions. This false belief dramatically increases among the parents with autistic children, although it diminishes in the geographical area with an on-going epidemic of a potentially preventable infection disease (*i.e.*, *Neisseria meningitidis*, groups B and C).



**Figure 2.** Belief in the autism-vaccination paradigm as a function of an ongoing epidemics for a potentially vaccination-preventable infectious disease (N=424 administered questionnaires; N=229 filled questionnaires).



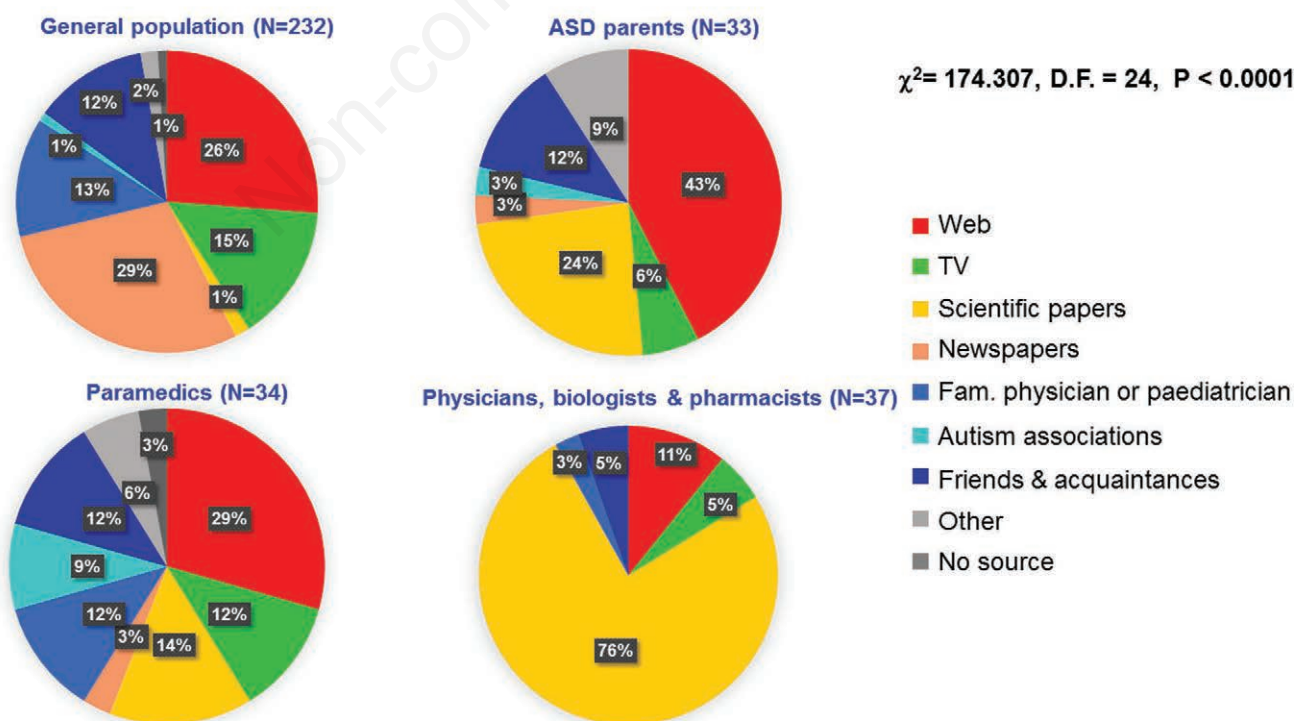
**Figure 3.** Belief in the autism-vaccination paradigm as a function of four population sub-categories (N=424 administered questionnaires; N=333 filled questionnaires).

Lack of scientific evidence on a causal relationship in the vaccine autism-paradigm seems to have little effect on the participants, even if paramedics and physicians, biologists or pharmacists. What the data tell us? What factors do affect people in giving a judgment or making a decision under risk?

Individual behaviour is always the result of a complex set of factors: personal disposition, environmental, cultural, relational, emotional and cognitive [10-12]. Each of these factors could affect the way in which we think (Figure 6). Humans have always to deal with i) the available information, which is never complete; ii) the short time to make decision; and iii) with the limitations in cognitive processing [13]. Theories on human reasoning [11,12] refer to two primary modalities of information processing. One rational, analytical and conscious, that foresees a rule-based behaviour. The other, fast, intuitive and automatic, based on heuristics and individual's experience (Figure 6). Even if one of the two processes may predominate over the other, they are not mutually exclusive. According to the results of this study judgment under risk situation seems to reflect these theories, being influenced mainly by environmental, social, cognitive and emotional factors.

In the present study, we have shown how the environmental context can affect the response of people interviewed. People who live in the geographical area with the meningococcus epidemic outbreak believe to a lesser extent in this paradigm. The situation at hand

shifts the focus on the risk run at the moment compared to a future hypothetical condition [14,15]. The fear of being infected appears to make individuals more prone to think that all vaccines are safe. Although the vaccine needed to counteract the epidemics (*Neisseria meningitidis*, groups C and B), at that time ravaging one of the geographic areas under investigation, was not the same vaccine to which the study questions specifically refers (*i.e.*, MMR), clearly humans tend somehow *to do all the same brush*, likely following an *availability heuristic* conditioning the decision making process [16]. According to the risk sensitivity theory [17], involving evolutionary considerations, individuals shift from risk aversion (*i.e.*, the usual condition), to risk preference whenever a strong need arises. On the contrary, if not moved by an ongoing epidemic, people, affected by other factors, can experience another kind of emotion: regret, an anticipated emotion for an outcome that could happen for a hypothetical choice. Research [18] has highlighted parents' fear to vaccinate their children taking into account the negative effects that vaccine could have. In this hypothetical outcome parents would feel responsible for eventual negative effects of a therapy. This leads most of them to think that vaccines are unsafe. In the case of parents of autistic children, who rather believe in the paradigm vaccine-autism, a suspected link between MMR vaccination and autism may provide an explanation of the causes of what happened to their children. Human beings try naturally to attribute an explanation to certain



**Figure 4.** Belief in the autism-vaccination paradigm as a function of information source by different population sub-categories (N=424 administered questionnaires, N=336 filled questionnaires).

occurrences [19]. Paradoxically, despite our everyday world is very often unpredictable, humans, by nature, cannot live with uncertainty and try to overcome the state of vagueness that give them malaise and anxiety, trying to give an answer to the lack of a scientific response.

Another aim of this work was to understand the information sources on which the paradigm is based.

Our investigation strongly suggests that it is very difficult for the laypersons to discriminate science from pseudoscience. Science journalists appear to play a key role to forge a scientific opinion in common people, given that, as our data confirm, people not qualified in the health science subjects tend to build up their own opinion overwhelmingly on web and media.

Our results highlight a significant correlation between those who get information through scientific reviews and who do not believe in the paradigm. We see for example that physicians, biologists and pharmacists, rarely believe vaccines can cause autism. They acquire information mainly through scientific journals and they have a background knowledge of the subject, as a result, we suppose they are less influenced by other sources of information, such as the web or friends and acquaintances. Conversely, the study highlights a significant relation between the web as main source of information and those who believe in the above mentioned paradigm in question. Curiously enough, newspapers were not considered a source of information for this topic. Information can be neutral, but it is not the case of how it is communicated.

How individuals search for information and the way in which individuals pay attention to it are key issues, together with the comprehensibility, the interest it arouses, as well as the modalities used to store and retrieve it from memory.

We can refer to two likelihood elaboration models where information processing is concerned. It foresees a central route, a deep processing which can lead us to change our attitude in a more stable way, and a peripheral route, faster, acting through the peripheral signals and not on the content of the message [20]. In this case, individuals use heuristics to elaborate information, a message has a scientific appearance if it reports statistical data, and people think the message is true if it is communicated by an expert or a person that they trust, such as friends or acquaintances.

The content of the information and the context in which they are located may affect the processes of reasoning and decision making [21,22]. As far as risky choices are concerned, we may get different answers whether an identical message is set according to losses or gains. Researchers [23] maintain that emotional arousal in response to stimuli, which is fast and instinctive, orients our reasoning and our behaviour accordingly. In fact, risks and benefits of an occurring event are perceived differently if the feelings towards it are positive or negative [24-26]. If they are positive,

individuals tend to judge the event as having low risks and high benefits, the opposite occurs if feelings are negative. In this case, the event is judged as highly risky with few benefits.

Emotions serve as a drive and motivate our behaviour to reach out our biological advantage [27-29]. Likewise, fear is often used to persuade individuals to behave in a given way, relying on the negative consequences that could occur if you do not act or acts in a certain way. Fear can also be effective in making people pay attention, but only when it is moderate and a pos-

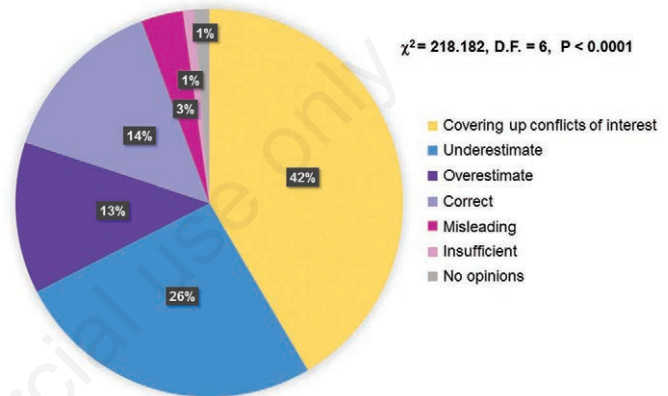


Figure 5. Distribution of opinions towards the role of institutional media in a possible *global conspiracy* (administered questionnaires N=424, filled questionnaires N= 231).

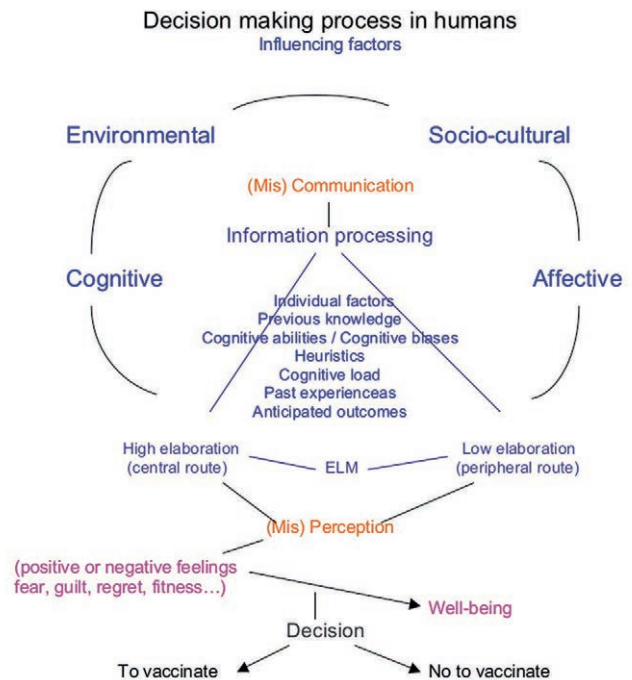


Figure 6. Information processing and decision making model in humans.

sible solution is offered. Fear, like other emotions, can have a different drive, depending on personal disposition, the context, the affecting moment (*i.e.*, the geographic area can lead to a favourable disposition towards vaccines if hit by the epidemic, but, at the same time, it can lead to misperception if friends, acquaintances, and people whom they trust, as well as social media, miscommunicate).

Individuals very often do not consider the likelihood of significant and weighty future consequences of a behaviour undertaken. In this way people tend to disregard considering the probability of occurrence.

To this regard, cognition and emotion are closely related and they both have systematic effects on decision making process and resulting behaviour.

A number of factors could lead decision makers to neglect to consider probability. Known factors that can influence the creation of a judgment under risk circumstances are: personal experience, culture, education, friends, mood, personality, age, gender. Therefore, it is important to pay attention not only to the content of information, but also to how and to whom it is communicated. In particular, lack of knowledge, for instance, can hamper the understanding of the basic meaning, the gist of the message, that needs to be simple and coherent to be easily processed and stored [30].

Concerns surrounding vaccinations have the potential to virally spread across the world in a fast and efficient manner [31]. Indeed, the information given in anti-vaccination websites is perceived as more coherent and emotionally eliciting, so easier to retain in memory [31].

This point should be well taken in mind as most people trust the web for health information despite the fact that accuracy and reliability of its content are not easy to assess by unknowledgeable users.

## CONCLUSIONS

These observations lead us to consider as a presumable assumption that the problem of the public declining confidence in vaccination could have more psychological and sociological bases rather than medical ones. Moreover, instability of the environment and complexity of the decisional process may hamper proper and adequate health information campaigns. In this contest, political leader's misuse of the epidemiological data and possible manipulation of the layman people misperception could lead to populist statements, increasingly used in the political scenario [32].

A better understanding of the relation between cognition and emotion is of paramount importance in order to improve our knowledge about the way to communicate and how information is perceived if we want to help humans in making correct judgments and rational choices. Of course, this becomes particularly rel-

evant when major public health issues are concerned.

From the data of the present study, we conclude that information source and emotional involvement are key influencers of over scientific evidence on the misperception of the vaccine-autism paradigm, thus potentially fuelling the resurgence of vaccine-preventable diseases, with predictable major public health consequences.

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## REFERENCES

1. Wakefield AJ, Murch SH, Anthony A, et al. Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. *Lancet* 1998;351:637-41. Erratum in: *Lancet*. 2004;363:750. Retraction in: *Lancet* 2010;375:445.
2. Leslie DL, Kobre RA, Richmand BJ, et al. Temporal association of certain neuropsychiatric disorders following vaccination of children and adolescents: a pilot case-control study. *Front Psychiatry* 2017;8:3.
3. Kalkbrenner AE, Schmidt RJ, Penlesky AC. Environmental chemical exposures and autism spectrum disorders: a review of the epidemiological evidence. *Curr Probl Pediatr Adolesc Health Care* 2014; 44:277-318.
4. Taylor LE, Swerdfeger AL, Eslick GD. Vaccines are not associated with autism: an evidence-based meta-analysis of case-control and cohort studies. *Vaccine* 2014;32:3623-9.
5. Ng M, de Montigny JG, Ofner M, Do MT. Environmental factors associated with autism spectrum disorder: a scoping review for the years 2003-2013. *Health Promot Chronic Dis Prev Can* 2017;37:1-23.
6. Leckman JF, Vaccarino FM. Editorial commentary: What does immunology have to do with brain development and neuropsychiatric disorders? *Brain Res* 2015;1617:1-6.
7. Morbillo. Ministero: "Ad aprile 385 casi. Cinque volte più del 2016". *La Repubblica*, 4 May 2017.
8. Morbillo, Italia maglia nera d'Europa. *La Repubblica*, 24 April 2017.
9. Italian Ministry of Health. Press release n. 28. Incremento casi mor-

- billo in Italia. Lorenzin: "Intervenire rapidamente per piena applicazione piano vaccini". 16 March 2017.
10. Gutnik LA, Hakimzada AF, Yoskowitz NA, Patel VL. The role of emotion in decision-making: a cognitive neuroeconomic approach towards understanding sexual risk behaviour. *J Biomed Inform* 2006;39:720-36.
  11. Epstein S, Pacini R, Denes-Raj V, Heier H. Individual differences in intuitive-experiential and analytical-rational thinking styles. *J Personal Soc Psychol* 1996;71:390-405.
  12. Kahneman D. *Thinking, fast and slow*. New York: Farrar, Straus and Giroux. *J Biomed Inform* 2011;39:720-36.
  13. Gigerenzer G, Gaissmaier W. Heuristic decision-making. *Ann Rev Psychol* 2011;62:451-82.
  14. Mellers BA, Schwartz A, Ho K, Ritov I. Decision affect theory: emotional reactions to the outcomes of risky options. *Psychol Sci* 1997;8:423-9.
  15. Schwarz N. Emotion, cognition, and decision making. *Cogn Emot* 2000;14:433-40.
  16. Tversky A, Kahneman D. Judgment under uncertainty: heuristics and biases. *Science* 1974;185:1124-31.
  17. Mishra S, Gregson M, Lalumière ML. Framing effects and risk-sensitive decision making. *Br J Psychol* 2012;103:83-97.
  18. Ritov I, Baron J. Reluctance to vaccinate: omission bias and ambiguity. *J Behav Decis Making* 1990;3:263-77.
  19. Malle BF. *How the mind explains behavior: folk explanations, meaning, and social interaction*; Cambridge: MIT Press; 2004.
  20. Petty R, Cacioppo J. *The elaboration likelihood model of persuasion*. NY: Academic Press; 1986.
  21. Tversky A, Kahneman D. The framing of decisions and the psychology of choice. *Science* 1981;211:453-8.
  22. Reyna VF, Nelson WL, Han PK, Dieckmann NF. How numeracy influences risk comprehension and medical decision making. *Psychol Bull* 2009;135:943-73.
  23. Zajonc R. Feeling and thinking: preferences need no inferences. *Am Psychol* 1980;35:151-75.
  24. Peters E, Slovic P. The spring of action: affective and analytical information processing in choice. *Personal Soc Psychol Bull* 2000;26:1465-75.
  25. Loewenstein G, Weber E, Hsee C, Welch N. Risk as feelings. *Psychol Bull* 2001;127:267-86.
  26. Slovic P, Peters E. Risk perception and affect. *Curr Direct Psychol Sci* 2006;15:322-5.
  27. Ekman P. An argument for basic emotions. *Cogn Emot* 1992;6:169-200.
  28. Damasio AR. *Descartes' error: emotion, reason, and the human brain*. New York: Avon; 1994.
  29. Fessler DMT, Pillsworth EG, Flamson TJ. Angry man and disgusted women: an evolutionary approach to the influence of emotions on risk taking. *Organ Behav Human Dec Proc* 2004;95:107-23.
  30. Reyna VF. Risk perception and communication in vaccination decisions: a fuzzy trace theory approach. *Vaccine* 2012;30:379.
  31. Betsch C, Brewer NT, Brocard P, et al. Opportunities and challenges of web 2.0 for vaccination decisions. *Vaccine* 2012;30:3727-33.
  32. The Editorial Board. *Populism, politics and measles*. *The New York Times*. 2 May 2017.