Communication & Science JOURNAL

Date Received:
2019 Nov 15

Published:
2019 Dec 3

MESSAGE STRATEGIES TO IMPROVE THE IMAGE OF CRISPR[1]

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[1] Support for this research was provided by Innovative Genomics Institute, University of California, Berkeley, CA, USA, and by the Galileo Research Group at Buffalo, State University of New York.

A RAH Press Publication
http://www.comSciJ.com

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Prepared for

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May, 2019

SUMMARY

This report describes the results of research conducted for the University of California's Innovative Genomics Institute to determine public perceptions of CRISPR and genome editing. The goal of this research is to design a communication strategy that would, when implemented improve the public's image of CRISPR.

This research was conducted in two phases. Phase 1 conducted in the spring of 2018, consisted of 93 interviews with scientists, farmers and policy makers, as well as the general public. From these interviews the concepts that make up their attitudes toward CRISPR and genomic editing were determined. Phase 2 consisted of the quantitative measurement of the relationship among these concepts by a sample of 106 undergraduate students at a public university center in the northeastern United States. The second phase took place during the spring 2019 semester.

This report describes the results of the quantitative phase of the research. The results indicate that the subjects have little knowledge about CRISPR. The optimal communication strategy to position CRISPR closer to the self-concept was determined to include the concepts *beneficial*, *ethical* and *people*. If implemented, this message would improve CRISPR's image by approximately 84.%.

Finally, it is recommended that this research be replicated in the future with a more representative sample, once the public has gained greater knowledge of CRISPR and genomic editing.

METHODS

Ninety-three (93) structured telephone interviews were conducted with biologists, policy makers, farmers and the general public conducted spring 2018. Respondents were asked where they got their information about food, agriculture and science, their familiarity with the term's genome and genomic editing, how genomic editing might be used in society and agriculture, as well as, its positive and negative aspects. Based on a computer-based content analysis 12 concepts were identified as the most important in determining the subjects' perceptions of CRISPR.

The concepts were:

1. Beneficial
2. Harmful
3. Food
4. Genome Editing
5. Health

6. People
7. Science
8. Medicine
9. Cancer
10. Ethical
11. GMO
12. CRISPR
13. UC Innovative Genomics Institute
14. Nurses
15. Myself

Three additional concepts, *UC Innovative Genomics Institute* and *Nurses*, as potential message sources and *Myself*. The concept *myself* was included because it provides the location toward which CRISPR can be directed to improve the respondents' attitudes toward the acceptance of this genomic editing technology. Past research indicates that the closer respondents place a concept toward the self-concept (myself) the more positive their attitude and the more likely they are to engage in behaviors such as purchasing a product, performing a behavior, voting for a candidate or supporting an organization.

One hundred and six undergraduate students at a public university center in the northeastern United States were asked to complete a survey during the spring 2019 semester. The survey included 105 direct pair-comparisons that measured their perceptions of genomic editing and CRISPR. Subjects were asked to estimate the difference or distance among all possible pairs of words or phrases on an open-ended scale, where 10 represented the distance between the concepts "GMO" and "organic food". A response of 0 indicates that the words or phrases are perceived as identical, a number less than 10 that the concepts are more similar that GMO and organic food, and a number greater than 10 that the terms were less similar than GMO and organic food. Subjects were instructed to report a larger number the greater they perceived the dissimilarity among the terms.

RESULTS

Concept Perceptions

The overall mean (average) distances are presented in Table 1. The results indicate that the subjects had some difficulty completing the task. The average completion rate ranged from 72.3% to 100.0%, depending on the specific pair. The subjects had the greatest difficulty estimating *CRISPR*'s distance from the other concepts due to a lack of knowledge about the concept. Only 79% of the pair-comparisons that involved CRISPR were completed. Forty-two (42) estimates were removed from the data because they were equal to or greater than 1,000. This represents less than .4%of the total response that exceed 11,000. The average standard error was 2.83%, low for a sample of this size.

TABLE 1 ABOUT HERE

The overall average (mean) reported value was 13.96 units. The smallest reported value was between *beneficial* and *science*, 4.50 units, and *beneficial* and *medicine*, 4.66 units. The largest reported differences among the concepts were between *beneficial* and *cancer*, 41.56 units and *harmful* and *myself*, 34. 10 units. This indicates that the subjects perceive that science and medicine are beneficial and that cancer is not beneficial and that they do not perceive of themselves as harmful.

An examination of the attitudes toward the specific concepts is displayed in Figure 1 below. It displays the reported distances between the self-concepts and the other 14 items. The smaller the distance, the more positive the attitude. It clearly shows that the respondents are most positive about people and beneficial, and most negative about harmful and genome editing. Figure 1 also displays the distances of each concept from *CRISPR*. CRISPR is most closely identified with *science* and *GMO*.

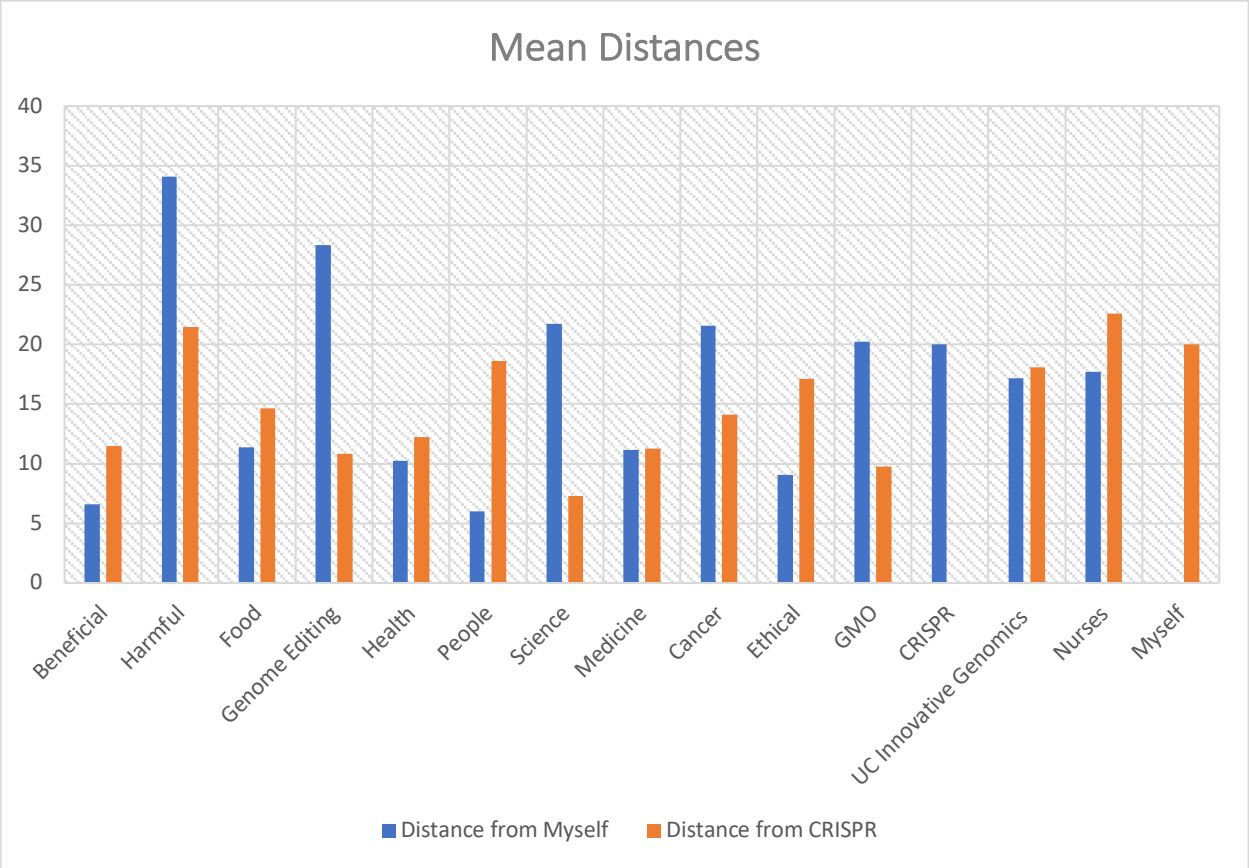


FIGURE 1: SUBJECT PERCEPTIONS

The mean values were next converted to Cartesian coordinates in the same manner that intercity distances may be transformed to location on the axes of latitude and longitude. Technically, this process is known as multidimensional scaling. The coordinates are presented below in Table 2. From the coordinates a three-dimensional map was drawn. It is presented as Figure 2.

TABLE 2 and FIGURE 2 ABOUT HERE

Dimension 1 differentiates *beneficial* from *harmful* and *cancer*. Basically, it separates those concepts perceived positively (*beneficial, ethical, nurses* and *myself*) from those viewed as negative (*harmful, genome editing* and *cancer*). The second dimension differentiates *beneficial, harmful, food* and *genome editing* from *cancer, nurses, ethical* and *myself*. *Medicine* is closer to the later set of concepts, while *CRISPR* is closer to the former. Thus, this dimension differentiates the medically related terms from the others. The third dimension separates *myself* and *food* from *UC-IGI, GMO* and *genome editing*.

It should be noted that while physical distance can be described accurately in two or three dimensions, psychological distance is multidimensional. In this case, 14 dimensions are required to precisely describe the relations among the concepts. The three dimensions in Figure 2 account for only 78.1% of the total variance. The first two dimensions account of only 63.1%. As a result, any conclusions drawn from Figure 2 should be viewed with caution. It is recommended that any decisions be made based on the mathematical analysis described herein.

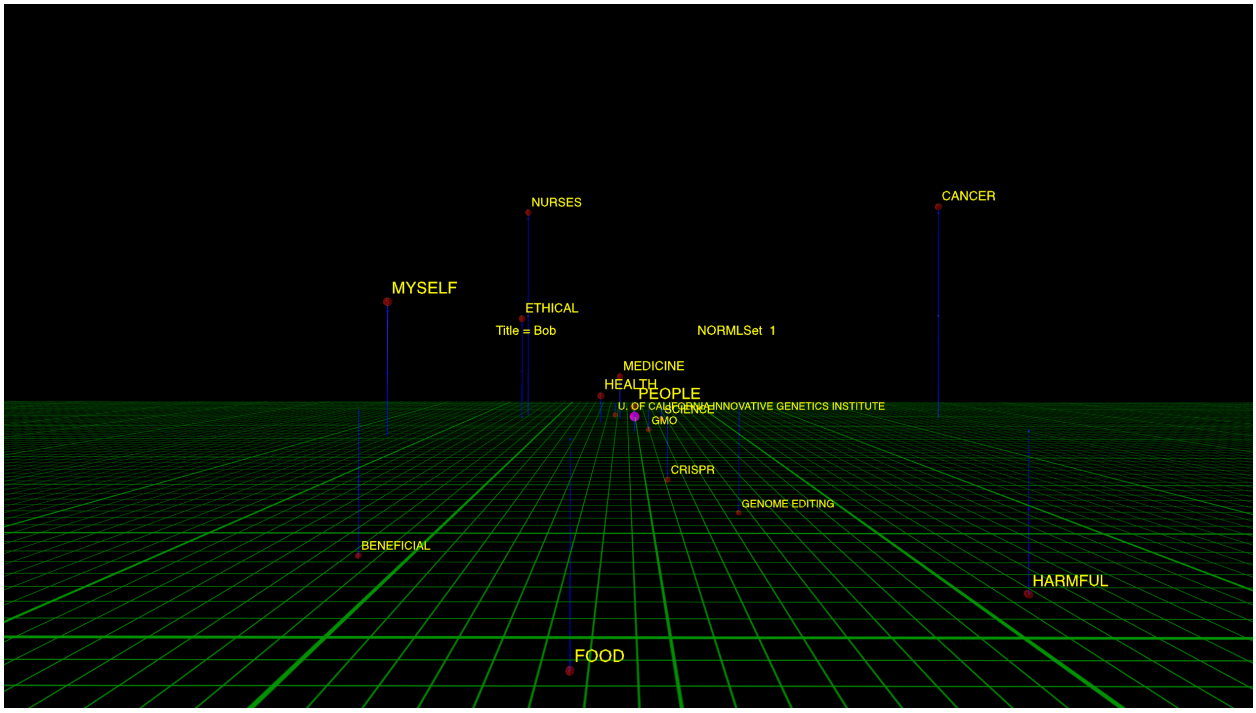


FIGURE 2:
CRISPR SPACE IN THREE DIMENSIONS

The creation of Cartesian coordinates through multidimensional scaling makes it possible to develop communication strategies which when implemented will reposition the concepts in the coordinate space as desired. Basically, the theory behind the procedure is as follows: A vector analysis is performed by considering all the concepts' positions. A target vector is drawn between the concept whose position one wishes to change and its desired location. In this case, we want to reposition *CRISPR* closer to *myself*. Then, resultant vectors are determined based upon the concepts' locations. They are designed to reposition the concept to be changed (*CRISPR*) as close to the desired location (*myself*) as possible using the other concepts in the space. From this group of concepts a communication strategy is developed which closely confirms to the target vector and the concept.

The explanation of the procedure is as follows: Messages act as forces that alter the position of concepts in the perceptual space. When two words or phrases are associated in the same

message, they approach each other in the space. When a number of concepts are associated in the same message, all concepts in the message approach the common center of the concepts in the message. Since the distances among the points in the space represent the relationships among the concepts in the minds of those who completed the interviews, these movements represent changes in attitudes or perceptions. Thus, when we try to move CRISPR closer to myself, we are in effect trying to bring this concept closer to the kind of issue the average respondent would identify with and support with their behavior. This is graphically displayed in two dimensions as Figure 3. Note that this representation accounts for less than two-thirds (63.1%) of the variance in perceptions.

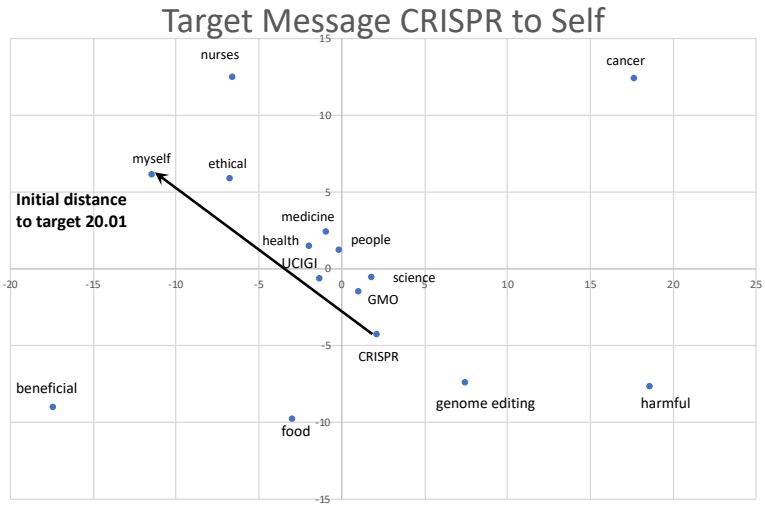


FIGURE 3: TARGET MESSAGE

A communication strategy was developed to reposition *CRISPR* closer to the average self. 176 positive messages were examined. All 1, 2, and 3 concept combinations that would move *CRISPR* in the desired direction closer to *myself* by at least 25% of the reported distance were examined. Each message was evaluated to the extent to which it has the potential to move *CRISPR* closer than this initial distance, 20.01 units, to the position occupied by the average of the respondent's selves. The four best messages are presented in Table 3. Statistically, they are equivalent in quality.

TABLE 3

THE FOUR BEST MESSAGES TO POSITON CRISPR CLOSER TO MYSELF

Message Concepts	Final distance from Myself Percentage Improvement.	Angle
1. Beneficial Health Cancer	2.97 (85.25%)	68.8^{o}
2. People Ethical	3.12 (84.4%	82.9^{o}
3. Beneficial Ethical People	3.25 (83.8%)	50.0^{o}
4. Beneficial Medicine Cancer	3.31 (83.5%)	63.0^{o}

The final distances are expressed as percentage of the initial distance between *CRISPR* and *myself*. It was. 20.01 units. Thus, the smaller the value the better the message. The angles are expressed in degrees of the difference between the target vector and the vector resulting from the positions of the concepts in the message. Thus, the smaller the angle, the better the message. While the single best message based only on the resultant distance is composed of the concepts, *beneficial*, *health* and *cancer*, we believe that the most appropriate message would be the third best, which includes the concepts *beneficial*, *ethical* and *people*. The reasons for this are that this message has the smallest angle (50.0^{o}) and that the sentiment analysis conducted on the interviews found cancer to have negative connotations. Also, note the location of *cancer* in the figures. Along with *harmful,* it is one of the furthest concept and in the opposite direction from *myself*. Since people know little about genome editing technology, and specifically about CRISPR, we recommend not associating CRISPR with cancer in the minds of the public. Also, recent court ruling suggesting that Roundup, a Monsanto product associated with GMOs, causes cancer, we feel that pairing the concepts should be avoided. Further, there are no statistical differences in quality among these four messages.

Figure 4 graphically represents the concepts in the optimal message. Thus, the best message to improve perceptions of CRISPR would include the concepts *beneficial, ethical* and *people*. Such a message might be “CRISPR is ethical and beneficial for people”. Figure 5 shows the final

location for CRISPR. If this message were implemented, it would result in approximately 84% improvement in CRISPR's position.

FIGURE 4

MESSAGES IN THE OPTIMAL STRATEGY TO REPOSTION CRISPR

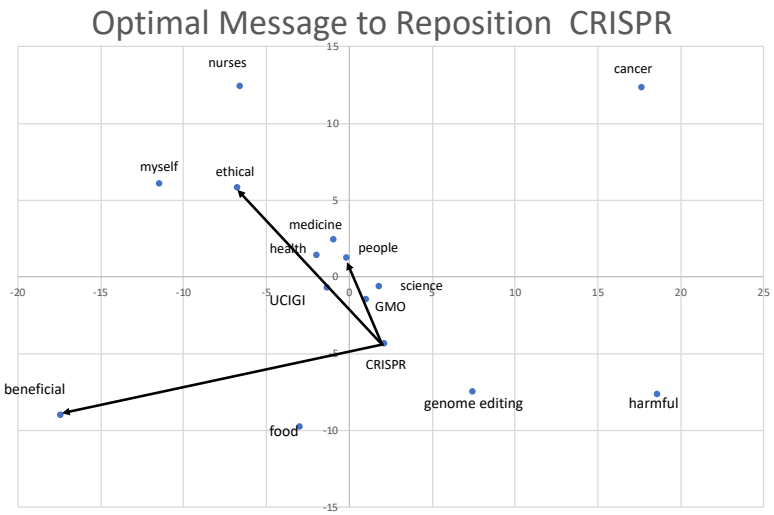
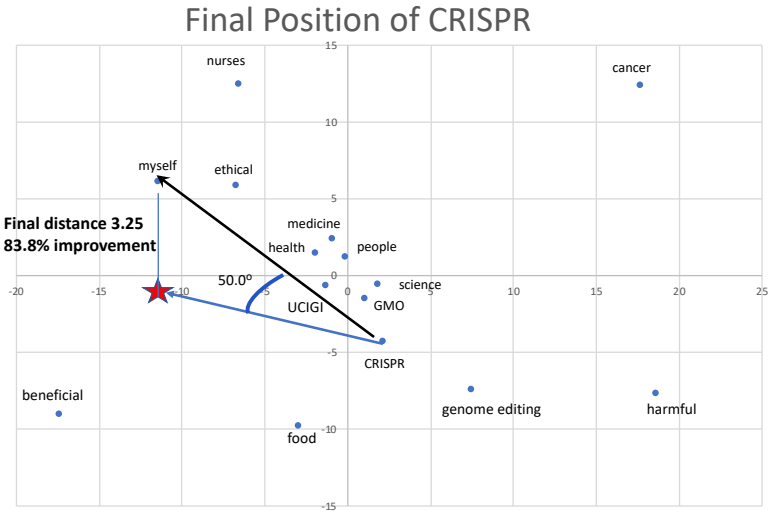


FIGURE 5

FINAL POSITION OF CRISPR



RECOMMENDATIONS

We recommend associating CRISPR with the concepts *beneficial, ethical* and *people* when the genome editing technology is discussed. The public has little knowledge about CRISPR and one should be able avoid the negative connotations that surround GMOs in the mind of the public through the mention of these positive concepts. If this message were consistently implemented, it would result in approximately 84% improvement in CRISPR's position. This is provided, of course, that there are no negative messages about CRISPR and genomic editing technology from other sources in the environment. It should be noted that this research was carried out with undergraduates at an Eastern state university research center. While that university places a great deal of emphasis on the life sciences, we feel that the recommendations should be employed with caution. Finally, it is recommended that this research be replicated in the future with a larger more representative sample, as the public gains greater awareness of CRISPR and other genomic editing technologies.