

# It's Comical: When Facts in Comic Form Persuade

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Multifrequency media access control has been well understood in general wireless ad hoc networks, while in wireless sensor networks, researchers still focus on single frequency solutions. In wireless sensor networks, each device is typically equipped with a single radio transceiver and applications adopt much smaller packet sizes compared to those in general wireless ad hoc networks. Hence, the multifrequency MAC protocols proposed for general wireless ad hoc networks are not suitable for wireless sensor network applications, which we further demonstrate through our simulation experiments. In this article, we propose MMSN, which takes advantage of multifrequency availability while, at the same time, takes into consideration the restrictions of wireless sensor networks. Through extensive experiments, MMSN exhibits the prominent ability to utilize parallel transmissions among neighboring nodes.

CCS Concepts: • **Computer systems organization** → **Embedded systems**; *Redundancy*; Robotics; • **Networks** → Network reliability;

Additional Key Words and Phrases: Wireless sensor networks, media access control, multi-channel, radio interference, time synchronization

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## 1 INTRODUCTION

Today, the world generates information all around us every second. We are surrounded by all sorts of messages trying to change what we think and what we do: our newsfeed is full of advertisements, our wearable devices are keeping telling us to exercise more, even our water bottle starts to push notification to remind us drinking more water. However, not all messages can successfully change our behavior: we won't buy an expensive car because of a short video, we often eat junk food even though we received a lot of articles about health eating and we are often in the status of dehydration after reading those notifications. Thus, how to make a message more persuasive has been a critical problem throughout the years.

While classical game theory suggests that recasting an informative message through a different form cannot increase the message's persuasive power, a rich body of research has demonstrated how susceptible we are to those fancy words. Hotel guests start to reuse their towels more because of a subtle change of a sign positioned on washroom towel racks. Households start to reduce their energy consumption because of an emoji on their energy bill. People are more willing to sign up for a prosocial peer-to-peer service because of a message on the sign-up page telling them explicitly

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what benefit they might get. Given the susceptible nature of our species, we believe changing the representation of a message can make the message more persuasive.

Comics, a medium to express ideas in a graphical form, are one of the most popular form of art across different cultures. The history of comics can be traced back to early precursors such as Trajan's Column. Comics are usually in the form of juxtaposed sequences of panels of images or a standalone single image. Beside the graphical representation, textual elements such as speech balloons, captions, and onomatopoeia often communicate dialogue, narration, sound effects, or other information. Existing work shows that reader often prefer comics over plain text since comics are more attractive and more engaging than plain text. Yet the persuasiveness of the comics representation has not been investigated.

In this study, we present a research on the persuasiveness of comic style messages. First, we reviewed some of the previous works on persuasive technologies in three major fields: (1) framing and phrasing of messages, (2) comparison between text and comic, and (3) communicating through comic and graphics. Second, we discuss about the general composition of a comic message and its comparison with plain text. Lastly, to examine our hypothesis that comic messages are more persuasive than text messages, we conduct a field experiment on Amazon Mechanical Turk to investigate the persuasiveness of comic messages comparing with text messages. The result shows comics can be a better form of persuasive message comparing to plain text and three key comic elements, character gesture, inter-character distance, and background shading moderate the persuasiveness differently.

The contributions of this work are: 1) extending on previous research to not only whether comic messages can attract reader's attention, but also whether comic messages can actually motivate readers to take action. 2) among the first to examine the effect on reader's behavior for comic form messages.

## 2 RELATED WORK

Research on making messages more persuasive has been increasingly dominant due to the fact of information explosion. We live in an era where we are immersed in the information ocean. How to make individual message stand out among others, attract attention from readers and persuade behavioral change becomes an important problem. A lot of research has worked on techniques that can make a message more persuasive. Some focused on the framing of messages, some focused on the context of the message, while others focused on more graphic and visual aspect of message to make the message more attractive to readers. We build our research of using visual comics to attract reader attention on the previous work from all focus. In the following sections, we will introduce some of the related studies categorized into groups: (1) framing and phrasing of messages, (2) comparison between text and comic, and (3) communicating through comic and graphics.

### 2.1 Message Framing & Phrasing

Approaches to make a message more attractive and persuasive has long been a focus for a variety of different fields including computational linguistic, social networking, and advertising. Among these tactics, message framing and phrasing is one of the most basic and intuitive methods to generate memorable and persuasive messages. This is mainly because message framing and phrasing generally doesn't require additional information or data visualization. Its simplicity contributes to the various researches on the effect of message framing in memorability. Mizil et.al shows that using unusual word choices and more general theme makes it easier to connect with reader's daily life and makes the message more memorable. Using unexpected words and phrases, the message is more likely to capture reader's attention comparing to normal phrases. As for the theme of the message, it should be as general as possible to help readers connect with the message, so it can stay in the reader's mind longer. However, using more general background and theme to connect with readers and special phrases to catch reader's attention is not only applied in text-based messages. Mr. McCloud shows that comics have been using similar techniques. Comics use general background and characters to make users feel more involved with the story, and use catchy phrases to catch user's attention to make the comic more appealing. The abstract characters and background in comics make it easier for readers to relate themselves to the story, thus attracting reader's interest and attention.

Tversky and Kahneman takes on a different aspect of the effect of framing. Instead of focusing on the word selection and sentence structure of a quote, this paper focused on how different reference point of a same sentence can result in reader's different response. It shows that variations of reference point of a decision can determine whether the reader will evaluate it as a gain or a loss, thus changing their decision. For example, choices involving gains are often risk averse and choices involving losses are often risk taking. Meanwhile, implying social norm through the message is another persuasive technique. Goldstein et. al conducted an interest experiment in the hotel on motivating environmental conservation. They found employing descriptive norms (e.g., "the majority of guests reuse their towels") has more persuasive power than solely mentioning environmental protection. And this normative message gets more persuasiveness when the described setting is closer to individuals' immediate situational circumstances (e.g., "the majority of guests in this room reuse their towels"). All those techniques are essential for our design of messages to persuade behavioral change. We believe comics and graphics compared to plain text can better express the feeling of gain or loss to readers through the character's gestures and background. Also, the nature of the comics encourages their reader to project themselves on the characters which provides a good opportunity to bring the reader closer to the message itself.

Established research supports our hypothesis that comic can be more persuasive to change reader's decision.

## 2.2 Comparison Between Text and Comic

This study isn't the first to address the comparison between text and comic. Previous research has focused on comparing whether text messages or image/comic messages are more attractive to readers [cite]. The results showed that image/comics can raise user's awareness and have a greater chance to persuade behavioral change. However, this study retrieves the comics from the internet on a certain topic instead of customized generated comic. The drawback of this approach is that it is harder to control the quality and characteristic of the comic. Different authors of comic might have very different drawing style, resulting in differing effects on persuasion.

Our work builds on top of the findings of this study that comic can better attract reader's attention. We generate customized comic messages from text messages to unify the comic style and evaluate the persuading effect. Aside from the comparison between text and comics, research has also focused on comparison between other forms of data and their effect in persuading behavioral change. Lin and Xiao compared two modes of presenting information about wind energy in brochure form: (1) photographs and (2) using cartoons as visual aids. To evaluate the effect, the research focused on comparing three measures: (1) audience's knowledge of, (2) attitudes toward, and (3) behavioral intentions regarding wind energy. Results show that there is no significant difference between using photographs or comics in terms of knowledge and attitudes. However, visual aids shown in the cartoon/comics version showed stronger behavioral intentions (e.g., greater willingness to support changes) than the photo group. Because of the abstractness of comics, it can better engage its readers in the messages compared to photographs, making readers more willing to adopt changes. In this study, it mainly focuses on comics' effect on persuading readers to agree on changes conducted by others. However, in our study, we focus on comic's effect on persuading readers themselves to adopt behavior change.

## 2.3 Comics Speak

Using comic to convey information isn't a new idea. Throughout the years, research on evaluating the effect of comic and graphic in communicating ideas have been more and more popular. From Mr. McCloud's work, it shows that different comic elements have different effects on the ideas and emotion communicated. For example, background shading, character gestures, and word balloon border style can all change the emotion and feeling associated with the message. This makes readers more emotionally engaged and more likely to accept the ideas conveyed by the comic. Other comic elements can help engage the readers, for example, research has shown that more abstract comic character can help readers relate themselves with the characters in the comic. This makes readers more engaged to the story and the idea expressed by the comic. Although previous studies have proved that comic can better attract reader's attention and engage them in stories, the research on using comic to convey formal information and persuade behavioral change is limited.

Our study builds on comic's characteristic of attracting reader's attention. We want to further extend the research by understanding if comic can not only engage the readers, but also motivate them to take action. From the study by Haughney, it proposed a comic-style solution to present qualitative research findings. The study proves that the modified comic panel layout for user experience reports can make it more likely for readers to read the whole report through. This study offers an innovative idea to present visual information through comic layout. In addition, text bubbles in the layout highlights additional information about the research and can better attract reader's attention compared to text label by the side of a report. However, this design is specifically for presenting visual information such as user interface feedbacks. It is difficult to apply it to other

forms of information or research findings. In our study, we utilize comic to present persuasive text posts and extend the research to examine the effect in persuading behavioral change.

### 3 METHOD

In this study, we composed persuasive messages in both plain text and comic representations to compare the difference in their persuasive power and potential elements in the comics that may influence the persuasiveness. The main goal of all messages are the same, persuading readers to engage more exercise. The main reason to choose this goal are 1) As a basic daily activity everyone has the need to exercise. 2) People can easily understand the message and relate to themselves. 3) Engaging more exercise is mostly based on audience own willingness instead of any other subjective resources.

#### 3.1 Composing Persuasive Messages in Plain Text

Borrowing the idea from Psychology and Behavioral Economics, the key persuasive technique we adopted here is implying social norm through the messages (e.g. how participant's friends are doing). Also, we incorporate the idea from Tversky and Kahneman that people will be influenced differently if the same message is framed as risk averse or risk taking. Therefore, we created two sets of messages that either framed from a positive standpoint or a negative standpoint.

The followings messages were presented in our study.

*Positive framed messages:*

- (1) In the past week, you spent more time at the gym than did 65% of your friends
- (2) Congrats! You have reached your goal of exercising three times a week.
- (3) Over the past month, you exercised more than did 90% of your friends.
- (4) Your exercise activity is in the top 20% of all your friends.
- (5) Over the past three weeks, you went to the gym more often than 60% of your friends did.

*Negative framed messages:*

- (1) In the past week, you spent less time at the gym than did 65% of your friends
- (2) Congrats! You did not reach your goal of exercising three times a week.
- (3) Over the past month, you exercised less than did 90% of your friends.
- (4) Your exercise activity is in the bottom 20% of all your friends.
- (5) Over the past three weeks, you went to the gym less often than 60% of your friends did.

#### 3.2 Communicating through Comics

As a form of art, the creation of comics has few limitations. Although there is no common template that could describe all comics, if we take a closer look at each comic, it is not hard to see that every comic consists of several fundamental components. We categorize these comic elements into different groups:

- (1) characters,
- (2) gesture,
- (3) background color/shading,
- (4) word bubble,

In this study, to represent persuasive messages in a comic form, we need to determine each of those four parameters.

As Steve McCloud mentioned, the reader is more likely to project him/herself onto the character in the comic when the comic getting abstract [citation]. By taking the perspective of the character, the reader will internalize the information his/her character trying to express or receive. If the information is persuasive, the internalization will imply a higher chance of expected behavior change. Therefore, in this study, we choose to use an abstract yet well-recognized comic style, the xkcd style created by Randall Munroe, in our generated persuasive comic messages.

Beside the abstractness of the character, we believe the relationship between characters is also important. In real world, previous research suggests that messages are more persuasive if the person communicating the ideas is someone the receiver related [citation]. People are more likely to believe their close friends than strangers [citation]. In abstract comics, the relationship between characters is usually modeled by the distance between characters [citation]. So, it is reasonable to believe the link still holds in the world of comics as the reader tends to project his/herself onto the character. Therefore, we hypothesized that the distance between characters in a comic may influence the persuasive power.

The gesture of a character is another important component in the comic. The gesture of a character can help reader to understand what happens and the emotion of the character. Different gestures also imply the intensity of an emotion. As a common technique, cartoonists often use the gesture to intensify the feeling that they want to express to the reader. For a persuasive message, the intensified emotion may make the message more memorable than a plain tone. Thus, in this study, the gesture is another key element that we believe may moderate the effectiveness of a comic message.

A rich body of research has demonstrated the relationship between color or background shading and the emotion. In comics, the color of elements or the background shading contributes significantly to the feelings as well. However, as xkcd style are mostly seen in black and white, we suspect and confirmed in our pilot study that color background does not go well with generated comics (see pilot test 1). In the main study, we only manipulate the background shading in gray scale to show its affect on the persuasiveness.

The word bubble is the most common place in comics to incorporate text information. In a persuasive comic, the word bubble expresses the text content of the message.

### 3.3 Generating Comics

In this study, we create a based template for all comic messages that includes two characters in a conversation and the scenario is 'One day, your friend has something to tell you.'

We developed an algorithmic comic generator that based on Comix I/O, an open source project that creates comics with stick figures using HTML markup. To maximizing the flexibility, we further developed the existing build with Canvas and rough.js. The generator allows us to create the comic representation of a persuasive message with variations in character's gesture, inter-character distance and background shading.

For gesture, we created the gesture library in a JSON format with two main categories: positive and negative corresponding to how the original message is framed, each with three levels of intensity.

For the distance between two character, we have three levels of variance from close to far as well. The three level of distance represents the relationship between to characters as close friends, friends, acquaintance, from close to far.

For the background shading, we have a total of three levels from white to dark grey. Each level represents a level of emotional intensity, white as lowest.

To make a fair comparison between plain text representation and the comic form, the content of text information is the same in both conditions.

In total, for each message we have a total of 27 variations in terms of character gesture, inter-character, and background shading. In this study, 270 comics was created corresponding to 10 plain text messages.

### 3.4 Study Design

To test our hypotheses, we designed and conducted a between-subject field study through Amazon Mechanical Turk. In the experiment, participants will see a total of five persuasive messages in both plain-text form and comic form side by side. Then, the participant will be asked which form of the message is perceived as more persuasive and how persuasive is it.

Once participants agreed to join our study, they will be randomly assigned to two conditions 1) positive message condition where all persuasive messages are framed in a positive way and 2) negative condition where all persuasive messages are framed in a negative way. In both condition, Participants will compare five persuasive messages.

For each persuasive message, the participant will compare the same message in plain text and in a comic form on a 7 item Likert scale.

*Display Order* To mitigate any potential bias toward the display order of the plain-text representation and comic-style representation. The display order is randomly assigned. Both plain-text representation and comic-style representation have equal chance to be displayed first on the left side.

*Attention Checker* To control the data quality, we embedded two attention checkers in the experiment. The first one appears after the third comparison and the second one shows up after the last comparison. Both attention checkers asked subjects to choose a comic that matches a simple description, e.g. "Which of the following comics has two characters?"

*Rating Scale Design.* The 7 item Likert scale is ranging from -3 (left) to 3 (right) where 0 means neutral. The direction of the scale flips corresponding to the position of the comic and plain text.

### 3.5 Pilot Tests on the Study Design

#### 3.5.1 Pilot Test 1 on Changing Background Color in XKCD Style Comics.

*3.5.2 Pilot Test 2 on Experiment Design.* Before the actual experiment, we first tested our design in a small scale. We deployed our study on Amazon Mechanical Turk and received total of 10 feedbacks in 5 hours. Surprisingly, 5 of 10 participants reports the scale is confusing. 3 of them reports the flipping scale makes they spend more time on figuring out which side is which. One participants said "When I am answering my last question, I suddenly noticed the scale is different. I noticed the order of text and graph is changing but never notice the scale is changing as well. That's really confusing!!"

Based on the valuable feedback from our pilot test, we reiterated our study design. In the final design, we fixed the order of the rating scale. However, since the order is fixed, potential demand characteristics may be introduced by the scale, e.g. the researcher may want me to choose the larger number or items on the right/left side is expected. To minimize potential biases, in our final design, another layer of randomness was added. The direction of the scale no longer changes respect to the position of the messages, but the direction of the scale is randomly assigned for each participant. Also, the number on the scale is replaced by text as neutral, slightly persuasive, text/comics is more persuasive and strongly persuasive.

### 3.6 Participants

We published our HITs on Amazon Mechanical Turk titled with "A short survey about your exercise motivation". The price tag for each HIT was \$0.50, which were the rewards the workers would get regardless of their performance. The threshold for participant to join our study is a 95% Approval Rate. On the HIT page, participants would see a link to our experiment site and a text input box for them to enter a six-digit completion code. Repeated worker will be rejected as we instructed in the task description.



## 4 RESULTS

### 4.1 Raw Data

In this section we describe the raw data counts, the number of participants, the number of people whose responses we dropped. The final number of observations

### 4.2 Analysis

We use a Bayesian formulation of the problem of identifying suitable predictors for the comic form. Formally:

$$z = \beta_0 + \sum_{i=1}^k \beta_i x_i \quad (1)$$

$$\beta_0 \sim N(\mu_0, \sigma_0) \quad (2)$$

$$\mu_0 \sim N((1+L)/2, L^2) \quad (3)$$

$$\sigma_0 \sim U(a, b) \quad (4)$$

$$\beta_i \sim N(\mu_i, \sigma_i) \quad (5)$$

$$\mu_i \sim N(0, L^2) \quad (6)$$

$$\sigma_i \sim U(a, b) \quad (7)$$

## 5 DISCUSSION

## REFERENCES

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