Using Tiny Viral Messages on Social Networks to Spread Information About Science and Technology: Elements of a Theory of Nanovirals

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Abstract. Viral messages reach a large number of people at almost no cost. However, the majority of viral messages are based on shocking or entertaining content. Is it possible to make other kinds of content go viral, such as science and technology news? I use conceptual blending analysis to analyze five representative, very small messages about solar technology that went viral (nanovirals). I identify four distinct viral strategies, that vary according to number of belief systems used, and whether the viral message confirmed or contradicted central beliefs. Finally, I use information systems modeling to depict a common viral mechanism underlying the strategies. I conclude with a practical heuristic to guide the design of nanoviral messages.

Keywords: Viral messages · Design science · Conceptual blending analysis
Information systems modeling

1 Introduction

One of the challenges that technologists and scientists face is informing the general public about their innovations and discoveries. One solution is to conduct a national advertising campaign. However, for small businesses and most researchers, such campaigns are prohibitively expensive.

One promising, and low-cost alternative to a national advertising campaign is to use viral messages on social media to spread news about innovations and discoveries. Viral messages can reach a wide audience in a relatively short amount of time, with almost no cost except the time needed to develop the message. However, most messages that go viral contain shocking or humorous content.

Figure 1 is an example of a typical viral message with shocking content that was seen by over a hundred thousand individuals in a single day.

The research question I explore in this paper is: can you design a viral message around technology content rather than shocking or entertaining content?

While there are many popular books that discuss viral strategies [2] and some research analyzing the dynamic spread of viral messages [4], there is little formal research on designing viral messages. To answer the research question, I analyze tiny

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Fig. 1. An example of a typical viral message. https://twitter.com/Jeggit/status/902048241646280704

messages about solar technology that have gone viral. Before describing the method, I briefly clarify my distinction between viral messages and nanovirals.

2 Background: Viral Messages and Nanovirals

A viral message is information that spreads freely from person-to-person within a population often, but not necessarily, via social media. By "freely", I mean that people spread the information naturally—they do not have to be incentivized artificially to do so. A single viral message can reach hundreds of thousands to millions of people (see Fig. 1).

Viral messages differ in length. Viral news articles and viral videos are on the high end of the spectrum, and viral messages on micro-blogging, social media platforms like Twitter are on the low-end. My research focuses on very small viral messages, which I call nanoviral messages, or *nanovirals* for short. Figure 2 is an example of the smallest nanoviral—a single emoji depicting an expressionless face.

While "very small" is relative, generally, nanovirals are distinguished from longer viral messages in terms of length and operation—their length is typically less than

Fig. 2. The smallest viral message—a single emoji. "Nanovirals" are viral messages less than several hundred characters. https://twitter.com/KDTrey5/status/885318651728904192

several hundred characters, and they rely more on *retrieving* existing experiences to generate sudden insight, a process I call *apperception shift*, when compared to longer viral message which focus on *creating* an experience in a receiver via comprehension.

As suggested by Fig. 2, where the text is only a single emoji, the key to a message going viral is understanding the subtext of the message. A method is needed that helps discover the subtext from the text of a message.

3 Method

One method used in cognitive linguistics for analyzing the underlying meaning, or subtext, of a message is conceptual blending analysis [1]. It is based on the idea that people integrate elements of different beliefs mentally, to arrive at the meaning of a statement. The aim of conceptual blending analysis is to reconstruct how people mentally integrate elements of beliefs to arrive at meanings. Recently, it has been applied to analyzing meaning in advertisements [6]. Figure 3 depicts the process.

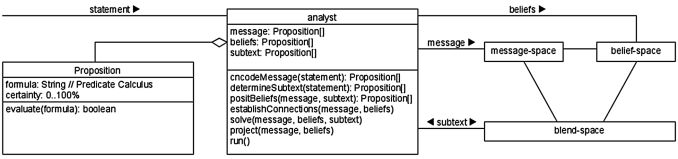

Fig. 3. Conceptual blending analysis on a nanoviral depicted as a hybrid class-communication model

Briefly, the unit of analysis is a statement. The analyst typically denotes the statement in propositional form, using the rules of predicate calculus. For example, the statement "Fred gave a rock to Wilma" in propositional form would be: Gave(fred, wilma, rock), where *Gave* is the predicate, and *fred*, *wilma*, and *rock* are terms.

Next, the analyst posits beliefs that the receiver of a message recalls in association with the message. These beliefs are also denoted in propositional form. The beliefs are put in a multi-column table, where each column denotes a *mental space*. Beliefs that have common (or synonymous) predicates or terms, are said to have a *pragmatic connection*, and are lined up row-wise in the table. Beliefs with pragmatic connections are special because their elements (predicates and terms) can substitute for one another in the blend.

Finally, the analyst selectively projects beliefs from the mental spaces into the blended space (or simply the "blend") to show the underlying meanings, the various subtexts, of the original statement. The blend is usually the last row in the table. An example should help clarify.

3.1 An Example of a Conceptual Blending Analysis

Table 1 depicts a conceptual blending analysis for the Kevin Durant tweet in Fig. 2. The timestamp of the tweet indicates that he posted it during ESPN's annual award show, the ESPY. During this show the emcee, Peyton Manning, made fun of Kevin Durant for switching teams in order to win a championship. When the camera panned to Kevin Durant he was not smiling, suggesting that he was mad, but one could not be certain based on the brief camera shot.

Table 1. Conceptual blending analysis for the Kevin Durant single-emoji tweet

Message (Tweet) Space	Belief (ESPY) Space
During(tweet, espy)	*peyton-manning* *kevin-durant* *P1: MadeFun(peyton-manning, kevin-durant)*
ExpressionLess(emoji)	*¬Smiling(kevin-durant)* *R1: P1 & ¬Smiling(kevin-durant)* → *Mad(kevin-durant)*
BLEND	
// Subtext: Kevin Durant is mad at Peyton Manning // for making fun of him // // Derived by substituting ExpressionLess(emoji) for // *¬Smiling(kevin-durant),* and projecting the substituted // rule, R1, into the blend: *P1* & Expressionless(emoji) → *Mad(kevin-durant)*	

Propositions representing the message are shown in the left column, the message (tweet) space. Possible beliefs retrieved by a reader as a consequence of the tweet occurring during the ESPY are shown in the right column, the belief (ESPY) space. This belief includes the rule that if Kevin Durant is not smiling he must be mad: … ¬Smiling(kevin-durant) → Mad(kevin-durant). There is a pragmatic connection between the expressionless emoji, ExpressionLess(emoji), and the proposition that Kevin Durant is not smiling, ¬Smiling(kevin-durant). In the blend, the expressionless emoji is substituted for this proposition, and readers of the tweet conclude that Kevin Durant is mad at Peyton Manning, which confirms their belief from watching the telecast.

3.2 Data and Apparatus

The data analyzed consisted of 330,827 tweets from the social media platform Twitter containing the hashtag #solar. I used SMEDA [5] as the social media scraping software. SMEDA is a custom module I wrote for Excel that scrapes tweets into an Excel worksheet. In addition to scraping it contains macros for organizing and sorting tweet content, and for building social network edges.

3.3 Procedure

SMEDA was run daily, over a two month period, from July 1, 2017—August 31, 2017. A total of 330,827 tweets were collected (N: 330,827; μ: 5335.92 tweets per day, σ: 1950.40). After the collection period, SMEDA was then used to sort tweets in descending order based on the number of retweets (shares). Tweets containing #solar, but unrelated to solar technology were thrown out. For example, there was a Korean music group who had a singer named Solar, and who would tag their tweets with #solar. All such tweets were deleted from the data set analyzed.

3.4 Procedure: Operationalizing Viral

Unlike viral messages containing entertaining or shocking content which receive thousands of retweets, messages with the #solar hashtag never received over a thousand retweets during the period scraped. Thus, rather than go with an absolute value to classify a tweet as viral, I used a relative measure. Specifically, given the author of a top-sorted tweet, I calculated the mean number of retweets over a week and the standard deviation. If the number of retweets was over one standard deviation I defined that as viral for that author, and the tweet was analyzed.

Figure 4 depicts the general hypothesis and theory building process. While conceptual blending analysis is a qualitative method, through iteration and triangulation, falsifiable theories can result.

It is beyond the scope of this paper to show every top tweet analyzed. Thus, in the results section I present just the analysis of five representatives of the top tweets.

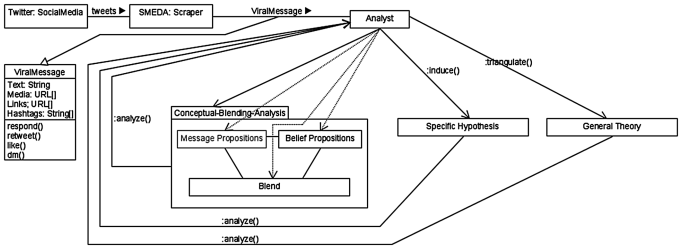

Fig. 4. The iterative procedure using conceptual blending analysis only on viral messages

4 Results

4.1 Representative 1: Fact Confirmation and Contradiction in Two Different Belief Systems—Progressive Version

The first tweet analyzed is from the DiCaprio Foundation (@dicapriodn) about the number of people employed in the solar industry versus the fossil fuel industry (see Fig. 5). The literal meaning of the text is clear: the solar industry hires more people involved in generating electricity than the fossil fuel industries combined.

The tweet contains: hashtags for Solar, Electricity, Oil, Coal, and Gas; a link to a Forbes news article for more information; and a user tag for @cleantechnica. The text of the tweet is taken from the title of the Forbes article that the tweet links to. Hashtags help spread the tweet to users searching on those tags, and a user tag displays the tweet on that user's mention timeline. Finally, there is a picture with a bar chart showing the number of people employed in the solar industry versus the fossil fuel industries. The picture sources the data to the Department of Energy.

As described in the method, I use conceptual blending analysis to discover possible subtext underlying the literal meaning of the text (refer to Table 2). The left-hand column contains propositions in predicate calculus form that correspond to the key content of the tweet. The right-hand column contains beliefs, both predicates and propositions (recall propositions are predicates filled-in with values), that the reader of the viral message could bring to mind as part in association with the text.

For example, the text mentions solar and fossil fuels. It is likely that readers will think of the beliefs of proponents of both solar and fossil fuels. If the reader is a renewable energy proponent, as many progressives are, a common belief is "solar is more important than fossil fuels", or in predicate calculus: Progressive(p) → MoreIm-portant(solar, fossil). The opposite is true if the reader is a fossil-fuel proponent, as many conservatives are: "fossil fuels are more important than solar", Conservative(c) → MoreImportant(fossil, solar). A reader may also recall general rules suggested by the text, in this case, "if some product x is more important than some other product y, more people will be employed making x than y"; in predicate calculus form: More-Important(x, y) → More(Employed(x), Employed(y)).

In the blend space the reader projects the "fact", or more precisely "a proposition

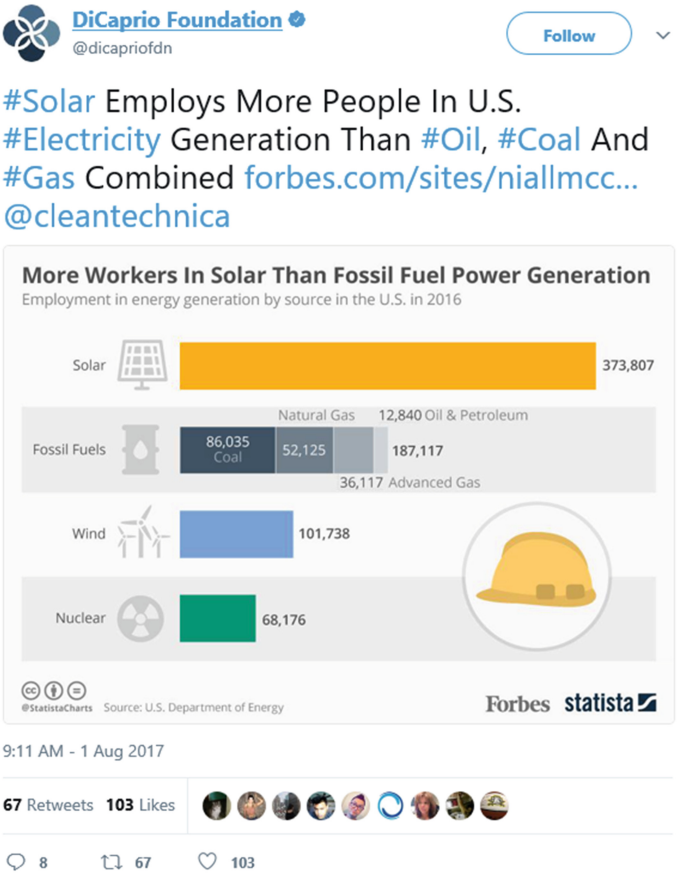

Fig. 5. Viral message from @DicaprioFdn, https://twitter.com/dicapriofdn/status/892417404428460032

with high certainty due to the source", that more people are employed in the solar than in the fossil fuel industry. The reader chains the propositions for both progressives and conservatives, with the general rule about product importance and employment, yielding a proposition that agrees with the facts in the case of the progressive belief, and disagrees with the facts in the case of the conservative belief.

Subtext confirming or discrediting widely-held, central beliefs is one of the most common occurrences in nanoviral messages, where I define "central belief" in terms of centrality in a network of propositions—a proposition that occurs in many of the propositional chains that constitute a belief system, c.f., node centrality in social networking theory. I call this the *confirm and contradict* strategy.

Table 2. Conceptual blending analysis for the @DicaprioFdn message

Message Space	Belief Space
More(Employed(solar), Employed(fossil)) Employed(solar, 373K) Employed(fossil, 187K)	*Progressive(p) → MoreImportant (solar, fossil)* *Conservative(c) → MoreImporant (fossil, solar)* *MoreImportant(x, y) → More (Employed(x), Employed(y))*
Blend Space: Agreement, Disagreement	
// Fact from message More(Employed(solar), Employed(fossil)) // fact in message // Subtext 1: Progressives beliefs about solar energy are correct // *via chaining to a proposition that agrees with fact* *Progressive(p) → MoreImportant (solar, fossil-fuel) → More (Employed (solar), Employed(fossil)) // **agrees** with fact in message* // Subtext 2: Conservatives beliefs about solar energy are incorrect // *via chaining to a proposition that disagrees with fact* *Conservative(c) → MoreImportant (solar, fossil-fuel) → More (Employed (fossil), Employed(solar)) // **disagrees** with fact in message*	

4.2 Representative 2: Fact Confirmation and Contradiction in Two Different Belief Systems—Conservative Version

The next example shows a variation of the *confirmation and contradiction* strategy. @AndrewCFollet's viral message (see Fig. 6) is about old solar panels causing environment problems in China. Although lacking details about how the solar panels are causing problems, the literal meaning of the text is clear. The structure of the message is similar to the first one analyzed, namely, the user repeats the headline of an article in the text, includes hashtags, links to an article, and tags users. However, instead of creating hashtags from the title the user specified tcot (Top Conservatives On Twitter), tlot (Top Libertarians In Twitter), and AGW (Anthropogenic Global Warming). The picture caption elaborates on the meaning of "environmental crisis", stating that "Old Solar Panels … in two or three decades will wreck the environment".

As in the previous analysis, we can represent the key propositions from the message in the left column of our conceptual blending analysis table (refer to Table 3), and possible propositions in the right column. The bottom row blends elements from both columns. The key proposition in the message text is: ¬Helps(OldSolar(panel), Environment(china)). While the predicates Wrecks or Hurts could have been used instead of ¬Helps, it saves time in the analysis from writing synonym propositions.

Fig. 6. Viral message from @AndrewCFollett's, https://twitter.com/AndrewCFollett/status/892432713667547136

The possible beliefs include: old solar panels are solar panels; solar panels produce solar energy; progressives believe that solar energy helps the environment; conservatives believe the US should not focus on solar energy; we should not focus on energy technologies that harm the environment. These beliefs, stated as propositions in predicate form, are in the right column.

In the blend, the subtext includes: solar energy hurts the environment of the United States; progressives are wrong about solar energy benefiting the environment; and conservatives are right not to focus on solar energy. Unlike the previous example, this viral message contains a proposition that contradicts a widely-held progressive belief, while supporting a widely-held conservative one.

Although the details of the blending differ—both chaining propositions and substituting elements of propositions—the outcome of the blending is the same: a confirmation of a central belief in one belief system, and a contradiction of a central belief in another, opposing, belief system.

4.3 Representative 3: Confirmation and Counterfactual in a Single Belief System

Some users were particularly adept at creating viral messages. One user, @MikeHudema, often started off his tweets with the phrase "As Trump tweets" (see Fig. 7). In this case, the literal meaning of the text, masks complex subtext aimed at denigrating the current president via contrast with a former president. The structure of the tweet is:

Table 3. Conceptual blending analysis for the @AndrewCFollett message

Message Space	Belief Space
Environment(china) ¬Helps (OldSolar(panel), Environment(china))	*Environment(us)* Old(Solar(panel)) →*Solar(panel)* *Solar(panel)* → *Solar(energy)* *Progressive(p)* → *Helps(Solar(energy), Environment(us))* *Conservative(c)* → *¬Focus(Solar(energy))* *¬Helps(x, Environment(x))* → *¬Focus(x)*
Blend Space: Contradiction & Confirmation	
// Subtext 1: Old Solar Panels won't help the US environment either // *Derived via substitution from fact in Tweet space* ¬Helps (OldSolar(panel), Environment(china)) → ¬Helps (OldSolar(panel), *Environment(us)*) // substitution // Subtext 2: Solar Energy won't help the US environment // *Derived via substitution of Solar(Energy) for Solar(Panel)* Old(Solar(panel)) → *Solar(panel)* → *Solar(energy)* ¬Helps (*Solar(energy)*, Environment(china)) // substitution *¬Helps (Solar(energy), Environment(us))* // substitution // Subtext 3: Progressives are wrong about solar energy helping // the environment *Progressive(p)* → *Helps(Solar(energy), Environment(us))* // *contradicts Subtext 1* // Subtext 4: Conservatives are right not to focus on solar energy *¬Helps(x, Environment(x))* → *¬Focus(x)* *¬Helps (Solar(energy), Environment(us))* → *¬Focus(SolarEnergy)* *Conservative(c)* → *¬Focus(SolarEnergy) // confirms belief*	

message, hashtags, link to news article, and picture from news article. The hashtag #resist refers to a movement consisting of individuals against current-president Trump.

In the message space (refer to Table 4, left column), you have two actors, Trump and ex-president Jimmy Carter. There are also propositions that denote Trump tweets, that Jimmy Carter built a solar farm, and that the solar farm powers half the city. In the belief space (right column) you have the fact that Trump is president, and a progressive belief that Trump tweeting is a useless activity. There is a pragmatic connection between the solar farm powering half the city and the city using the solar farm.

Fig. 7. Viral message from @MikeHudema, https://twitter.com/MikeHudema/status/885139695377797121, 69.5K; source: futurism

Finally, you also have the general belief that if someone builds something used by others, then the builder is useful.

The blend contains three pieces of subtext. The first is that the current president is useless, which confirms a progressive belief. This is contrasted with the second subtext, which states that the former president is useful. The second subtext is important because it provides a kind of proof that progressives can cite if challenged on why they believe the current president is useless. Finally, we know that people constantly engage in counterfactual thought, and that it can result in negative emotions like anger and regret [3, 7]. The third subtext is the counterfactual: if current-president Trump had only built a solar farm, he would be useful.

Unlike the previous two examples—which employed two belief systems, confirmations, and a contradictions—this viral message employed a single belief system, confirmations, and a counterfactual. While one may argue that a counterfactual is a contradiction, I reserve the use of counterfactual for those contradictions involving the substitution of people and technologies in action propositions that have positive or negative consequences. I call this the *confirmation and counterfactual strategy*.

Table 4. Conceptual blending analysis for the @MikeHudema message

Message Space	Belief Space
trump Tweets(trump) FormerPresident(carter) Build(carter, Solar(farm)) Powers(Solar(farm), Half(city))	*President(*trump*)* *Progressive(p)* → Tweets(trump) → *Useless*(trump) *Build(b,y)* *Using(y, x)* *Build(b,y) & Using(y,x)* → *Useful(b)*
Blend Space: Confirmation & Counterfactual	
// Subtext 1: Current President is Useless // *Derived by substitution into Progressive Tweets belief* *Progressive(p)* → Tweets*(*trump*)* → *Useless(*trump*)* → *Useless(President(*trump*))* // Subtext 2: Former president jimmy carter is useful // *Derived by substituting predicate Power for Using* // *and parameter substitution* Build(carter, Solar(farm)) & *Using*(Solar(farm), Half(city)) → *Useful(carter)* → *Useful(*FormerPresident(carter)) // Subtext 3: if Trump built a solar farm he'd be useful // *Derived by parameter substitution of Trump for Carter* // *and parameter substitution* Build(trump, Solar(farm)) & *Using*(Solar(farm), Half(city)) → *Useful(trump)* // ***Counterfactual***	

4.4 Representative 4: Wrong Economic Belief Indicating Technology Adoption

Not all viral messages about solar had political subtext. Another common type of viral message employed economic subtext (see Fig. 8). The literal meaning is straightforward: renewable energy will be cheaper than fossil fuels across the world in 3 years, according to the Morgan Stanley consulting firm. The structure of this message is like the previous examples, with the exception that the hashtags do not target specific political groups, and no other users are tagged.

The message space (refer to Table 5, left column) contains the proposition that the price of wind and solar will be less than the price of coal and gas in three years. The belief space (right column) includes the widely-held belief that renewable energies like wind and solar will always be more expensive than fossil-fuels, synonyms for renewables and fossil fuels, and the general belief that if the price of two equivalent items are similar, one should adopt the least expensive item.

Fig. 8. Viral message from @OurCarbon, https://twitter.com/ourcarbon/status/883742030072922112

The blend contains two subtexts. First, that it is wrong to believe coal & gas will always be cheaper than wind & solar; second, that renewables should be adopted in three years.

In the case of this viral message, contradicting a widely-held belief leads to a conclusion to adopt a technology. I label this strategy *present economic case*.

4.5 Representative 5: Argument from Majority

The final kind of viral message that one finds about solar, are those that provide news about other groups of people creating, using, or adopting a technology. In this example it is Australian households adopting solar panels (see Fig. 9). The structure of the message is similar to the previous example: text, hashtags, a link to a news article, and a picture.

Table 5. Conceptual blending analysis for the @OurCarbon message

Message Space	Belief Space
∀c ∈ countries, t ∈ date+3, Price(wind, solar, c, t) < Price(coal, gas, c, t)	∀c ∈ countries Price(wind, solar, c, ∞) > Price(coal, gas, c, ∞) *wind, solar = renewables* *coal, gas = fossil-fuels* *Price(x)< Price(y) → adopt (x)*
Blend	
// Subtext: You are wrong to believe coal & gas are cheaper than // wind and solar // *Derived by sample fact contradicting belief* ∀t ∈ date+3, Price(wind, solar, c, t) < Price(coal, gas, c, t) // fact Price(wind, solar, c, ∞) > Price(coal, gas, c, ∞) // contradiction // Subtext: You should adopt renewables // *Derived by equating wind & solar with renewables,* // *projecting the time conditions, and* // *substituting solar & renewables into general adopt rule* ∀c ∈ countries, t ∈ date+3, *Price(x)< Price(y) → adopt (x)*	

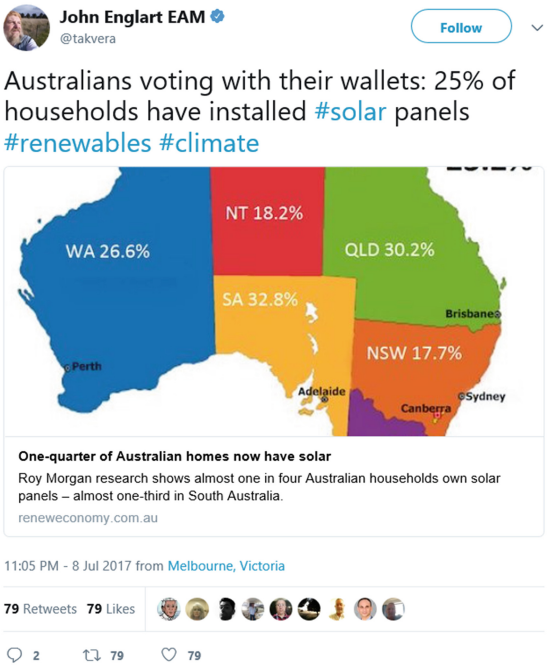

Fig. 9. Viral message from @Takvera, https://twitter.com/takvera/status/883929972812808193

In the message space (see Table 6, left column) are the propositions derived from the message, in particular that 25% Australian households have adopted solar panels. When a person reads such a message, it is natural to think of beliefs that compare or contrast the person's own group to the other group. In predicate calculus this is denoted by substituting predicates and parameters. Since the source group was Australian households, if the reader is American, the reader thinks of American households, and the fact that most American houses do not have solar panels installed. Whether or not this is bad depends on if these households are part of advanced nations, which in the case of Australia and America is true. Finally, there is the general belief that if an advanced nation is behind another advanced nation, it should catch up. Table 6, right column, summarizes potential propositions in the belief space.

In the blend, the subtext is that American households are behind Australians in terms of solar panel adoption and, being an advanced nation, should catch up. The viral message creates a new belief based on a propositions from the message combined with existing beliefs about progress. I label this strategy the *catchup strategy*.

Table 6. Conceptual blending analysis for the @takvera message (assumes reader is American)

Message Space	Belief Space
Australian(households) Have(Australian (households), Solar(panels), 25%)	*American*(households) Have(*American (households)*, Solar(panels), *LessThan*(25%)) *Have(x,y,z) & Have(a,y,LessThan(z) & AdvancedNation(x) & AdvancedNation(a)* → *Behind(a,x,y)* *Behind(a,x,y)* → *Catchup(a,y)*
Blend	
// Subtext: American households are behind Australian households // in adopting solar panels and should catch up // *Derived by substitution and chaining* Have(Australian (households), Solar(panels), 25%) & Have(*American* (households), Solar(panels), *LessThan*(25%)) & *AdvancedNation*(Australian (households)) & *AdvancedNation(American* (households)) → Behind(*American* (households), Australian (households) Solar(panels)) → *Catchup(American*(households), Solar(Panels)*)*	

5 Discussion: Strategies and Common Mechanism

We have examined five different viral messages that appear to use four seemingly different strategies. Next we use systems modeling techniques to triangulate to a common underlying viral mechanism that will serve as the basis for a design theory of nanovirals.

5.1 Modeling: The Physical Dataflow

In systems analysis, physical dataflow diagrams depict a system as is, with the agents (both actors and technologies) exchanging data. Initially I assumed a model of viral messages with the following data flow (see Fig. 10):

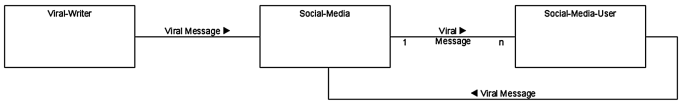

Fig. 10. Initial physical dataflow diagram

However, the analysis showed that news about events in the world was a central piece of every viral message. This news, created by some journalist and posted on a news website, can be understood as an input to the viral writer, as a key element of the viral creative process. Figure 11 depicts the revised diagram.

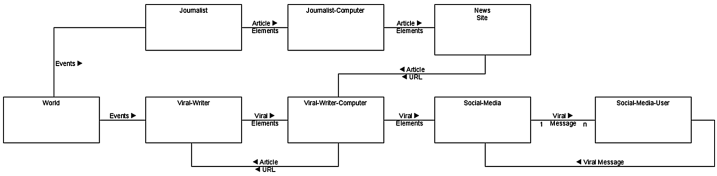

Fig. 11. Revised physical dataflow diagram based on the analysis

This revised diagram includes the viral writer's computer because it is a crucial tool used by the writer to search and organize news, as well as to compose the viral message. Note also that the diagram shows *viral elements* going from the writer to social media rather than a *viral message*. This is because the analysis made it apparent that social media formatted the final message viewed by users, which included the user's picture and information about date posted, retweets and likes.

From this diagram's inputs and outputs we can delineate four abstract processes to model: event, news, viral creation, and viral spreading (see Fig. 12). Finally, although not depicted explicitly in the process model, social media provides an input to the viral writer, serving as another source in the viral creation process.

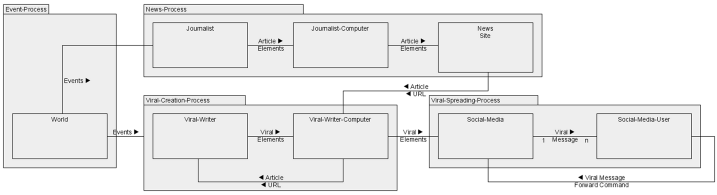

Fig. 12. The four processes to model. Messages from social media to the viral writer are implied but not shown.

To help construct a design theory of nanoviral messages that We will model two objects in two separate processes: the social media user in the viral spreading process, and the viral writer in the viral-creation process.

5.2 Modeling: The Social Media User in the Viral Spreading Process

Is there a common underlying mechanism in all the viral messages studied, which we can model? The analysis suggests, yes.

One can represent a viral message as a set of propositions. These propositions, through an associative mental process, retrieve beliefs from belief systems, which one can also represent as propositions.

Some of these beliefs are central to belief systems, e.g., "renewal energy is better than fossil fuel energy" in a progressive belief system, and vice-versa in a conservative belief system. I term such beliefs central beliefs, or central propositions. The intuition is that people use central beliefs to support explanations, predictions or actions. One can use centrality formulas from networking analysis to operationalize this term.

A social media user, given message propositions and central beliefs, will share a message if at least one of the propositions confirms or contradicts a central belief *and* the social media user determines that the confirmation or contradiction is not shared by his or her followers.

Figure 13 captures the main objects and the main information exchanged between objects.

Once shared, a message will continue to be shared if the belief systems of the followers (the message receivers) are consistent with the those of the sharer. This is likely why there are an abundance of political messages that go viral—progressive and conservative belief systems are consistent across followers, who in turn have followers with those belief systems.

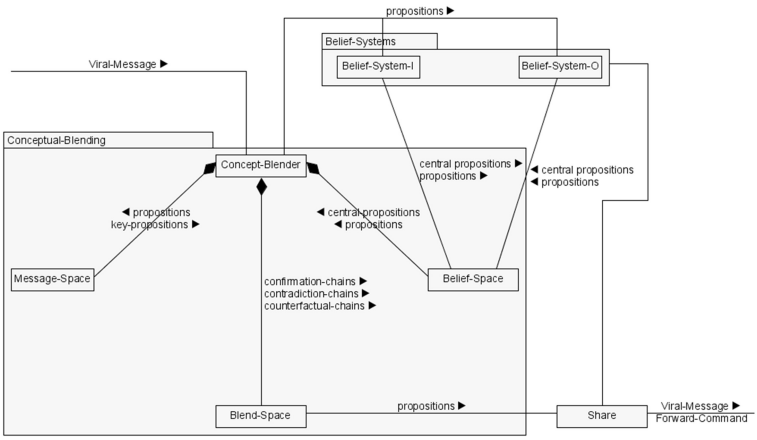

Fig. 13. Hybrid class-communication diagram for a social media user. The diagram depicts just two of many possible belief systems.

A message can both confirm and contradict central beliefs in separate belief systems, e.g., confirm a progressive belief while simultaneously contradicting a conservative one and vice versa, as the first two analyses showed. The decision rule for sharing is the same: if the sharer believes the confirmation and contradiction by followers, it will be shared.

5.3 Modeling: The Viral Writer in the Viral Spreading Process

The conceptual blending analysis analyzed the viral messages from the standpoint of a social media user reading them. While we did not analyze the viral creation process, it is possible that the same mechanism for comprehending a viral message, is used by a viral message writer to compose a viral message. Comprehension drives composition.

The primary difference is in input and output. An event happens in the world, which the viral writer either experiences directly or learns about via the news or social media. The viral writer represents the events, news, or social media messages as propositions, and if certain propositions confirm or contradict central beliefs, those propositions along with the central beliefs are the ingredients of a potential viral.

The decision to compose a viral message from those ingredients is similar to the sharing decision. A viral writer will create a viral message based on a contradiction or confirmation if the viral writer determines it is not shared by his or her followers.

The process of composing a viral message takes the confirmation or contradiction from the conceptual blending process and adds: supporting links, media (e.g., pictures and videos), user mentions, and hashtags. These viral elements are then sent to social media.

Figure 14 depicts how the viral creation process can leverage the viral spread process.

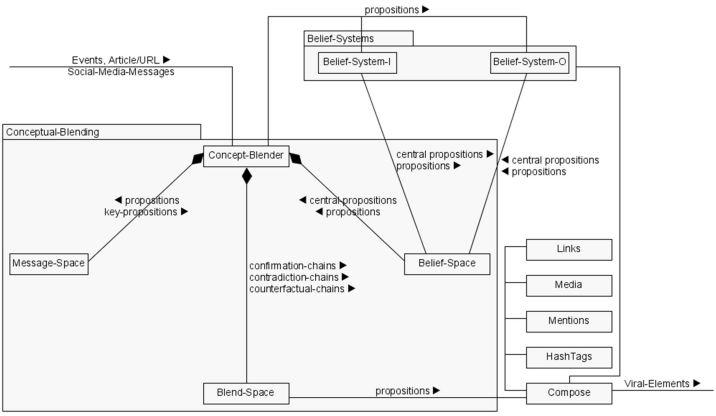

Fig. 14. Hybrid class-communication diagram for a viral writer. This composition process leverages the same conceptual blending & belief systems as the social media user.

6 Conclusion: A Heuristic and Future Research

In the old day of advertising, copywriters used formulas to help them write ads—Attention-Interest-Desire-Action (AIDA) was one, Picture-Promise-Prove-Push (PPPP) was another. There are analogous formulas for writing novels, screen plays, and video games as well. In the language of design science, these formulas are more properly thought of as "heuristics", because they don't guarantee success so much as they help focus one's effort in generating and in sequencing ideas for composition.

My analysis suggested the following heuristic—Check, Confirm | Contradict, Compose (CCCC):

- Check for news and other events, and based on that news
- Confirm central beliefs in shared belief systems, or
- Contradict central beliefs in shared belief systems
- Compose viral message around the confirmation or contradiction, adding in hash tags, mentions, media, and links.

The principle underlying the sharing of viral messages seems to be the *conservation of consistency in belief systems*. Messages are shared because they confirm beliefs that may be uncertain or, in the case of viral messages that show contradictions, they point out inconsistencies that must be repaired to maintain a consistent belief system.

The viral writer model in Fig. 14 suggests several areas for future research, which can help expand the theory. The first area is in terms of the source materials used by viral writers. For my #solar tweets, the source material was always a news article on some website. But the source could be a message read on social media from another user, or an event experienced first hand, or even a sudden realization of some confirmation or contradiction in one or more belief systems. How would the composition of the viral message change if the source was not a news article?

The second area of future research is belief systems. The viral messages I analyzed relied on no more than two belief systems. Is it possible to create a viral message that uses three or more belief systems? And it there are more than three belief systems, what are the "rules" for creating viral messages, beyond confirming and contradicting central beliefs? This is a question of process.

Process is the third area of future research. The viral rule in the data analyzed was the confirmation or contradiction of central beliefs. But the data also showed different ways for a news proposition to confirming a central belief, including early and late in a causal chain of propositions. The same was true of contradictions, especially in the use of counterfactual blends. More research is needed in specifying the details through which central beliefs get confirmed or contradicted. Finally, are there other rules beyond confirmation and contradiction, e.g., the connection of central beliefs from different belief systems.

The last area is composition. Future research is needed to clarify steps in this heuristic, especially the composition step. In particular, given a confirmation or a contradiction, or some other rule, what is the best way to state it and to support it with hashtags, mentions, media, and links. More research is needed, in particular, on the role

of hashtags and mentions in making a message go viral, especially if the viral writer does not have a large follower base.

In conclusion, I focused my analysis on viral messages for the hashtag #solar, in an attempt to discover a way of spreading information virally about science and technologies. I discovered that it was not the existence of a new discovery, or a new innovation that made the news spread, nor was the spread due to a description of how it worked, or what it could do for the reader. Rather, information spread if it confirmed or contradiction widely-held, central beliefs. Furthermore, the belief systems may have very little to do with the discovery or innovation, as was the case with the progressive and conservative belief systems—political belief systems.

Scientists who want to spread discoveries may want to focus less on describing the details of their findings, or less on describing future benefits, and more on how the discovery confirms or contradicts existing widely-shared belief systems, which may not have much in common with the discovery.

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References

1. Fauconnier, G., Turner, M.: The Way We Think: Conceptual Blending and the Mind's Hidden Complexities. Basic Books, New York (2008)
2. Gladwell, M.: The Tipping Point: How Little Things Can Make a Big Difference. Little, Brown, and Company, New York (2006)
3. Epstude, K., Roese, N.J.: The functional theory of counterfactual thinking. Pers. Soc. Psychol. Rev. **12**, 168–192 (2008)
4. Leskovec, J., Adamic, L.A., Huberman, B.A.: The dynamics of viral marketing. ACM Trans. Web **1**, 1–46 (2007)
5. Flor, N.: SMEDA — Social Media Exploratory Data Analytics Software. GitHub Repository (2017). https://github.com/professorf/smeda
6. Joy, A., Sherry, J., Deschenes, J.: Conceptual blending in advertising. J. Bus. Res. **62**, 39–49 (2009)
7. Roese, N.J.: Counterfactual thinking. Psychol. Bull. **121**, 133–148 (1997)