

The role of women in STEM disciplines. A multimodal analysis of crowdfunding project videos for the iGEM science competition.¹

El rol de la mujer en las disciplinas STEM. Un análisis multimodal de vídeos de proyectos de micromecenazgo para la competición científica iGEM.

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Resumen: La brecha de género en ciencia, tecnología, ingeniería y matemáticas (STEM, por sus siglas en inglés) es un asunto de creciente preocupación social: aunque la presencia femenina en estas disciplinas ha crecido durante las últimas décadas, los hombres siguen superando en número a las mujeres (Corbett & Hill, 2015). Se ha demostrado que esto se debe, en parte, a la falta de visibilidad que ha tenido el trabajo de las mujeres científicas a lo largo de la historia, lo cual ha generado creencias y estereotipos inconscientes sobre el género y las carreras profesionales, y por tanto, el desinterés por la ciencia por parte de las mujeres (Nimmegern, 2016). Investigaciones anteriores han demostrado que estos estereotipos se

Abstract: The gender gap in Science, Technology, Engineering and Mathematics (STEM) is a matter of growing social concern: although the female presence in these disciplines has grown during the last decades, men still outnumber women (Corbett & Hill, 2015). It has been shown that this is partly because of the lack of visibility that the work of women scientists has had a long history, which has led to unconscious beliefs and stereotypes about gender and professional careers, and therefore, the disinterest in science on the female side (Nimmegern, 2016). Previous research has shown that these stereotypes are reinforced through television programs depicting fictional women characters in STEM scenarios (Steinke, 2017; Davis & Coleman, 2018), and the

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refuerzan a través de programas de televisión en los que se representan personajes femeninos ficticios en escenarios STEM (Steinke, 2017; Davis & Coleman, 2018), y el presente estudio tiene como objetivo explorar la representación de científicas y científicos reales en Internet. Aplicando un análisis multimodal desde una perspectiva semiótica social, examino cómo se representan las identidades de género en ocho videos de proyectos de crowdfunding de ciencia creados por estudiantes de universidad para un concurso científico internacional, el *International Genetically Engineered Machine* (iGEM). Apoyándome en el enfoque de género Swalesiano de *move-analysis* para el contenido verbal (Swales, 1990, 2004), y en el modelo de Gramática Visual (VG) de Kress y van Leeuwen (2006) para el contenido visual, el análisis pretende identificar significados y propósitos ideológicos sobre los roles de género dentro de un contexto de investigación científica. Los resultados son compatibles con estudios anteriores que confirman que las mujeres están infrarrepresentadas en STEM, lo que pone de manifiesto las ideologías que conducen a reforzar el sesgo de género en puestos de trabajo científicos.

Palabras clave: mujeres en STEM; videos de proyectos científicos de micromecenazgo; análisis multimodal; sesgo de género; textos digitales.

present study aims to explore the representation of real female and male scientists on the Internet. By applying a multimodal analysis from a social semiotic perspective, I examine how gender identities are represented in eight crowdfunding project videos of science created by undergraduate students for an international science competition: the International Genetically Engineered Machine (iGEM). Relying on the Swalesian move-step analysis genre approach for the verbal content (Swales, 1990, 2004), and Kress and van Leeuwen's Visual Grammar (VG) model for the visual content (Kress & van Leeuwen, 2006), the analysis intends to uncover ideological purposes and meanings about gender roles within a context of scientific research. The results are compatible with previous studies that confirm that women are underrepresented in STEM, highlighting the ideologies that lead to the reinforcement of gender bias at the scientific workplace.

Keywords: women in STEM; crowdfunding project videos of science; multimodal analysis; gender stereotypes and bias; digital genres.

1. INTRODUCTION: FEMALE UNDERREPRESENTATION IN STEM. GENDER BIAS.

The fields of Science, Technology, Engineering and Mathematics (STEM) have been generally perceived as male domains ever since their very origins during the Age of Enlightenment. This may be no surprise given the long list of great male scientists that have been acclaimed, in contrast with the overall invisibility that the work of (also great) female scientists has had along history (Jones & Hawkins, 2014). The role women used to play in the past (i.e. cook, wife, mother and general homemaker) was usually not compatible with any professional career whatsoever, and those who challenged the norm with any bright entrepreneurial idea, were often silenced or had their accomplishments attributed to their male fellows and even their own husbands (Rossiter, 1993). Such was the case of Rosalind Franklin (1920- 1958) and her discovery of the double helix structure of DNA; Hedy Lamarr (1914- 2000) and her pioneering development of the nowadays ubiquitous WiFi technology; and Katherine Johnson (1918- 2020), the mathematician to whom the NASA owes the success of numerous spaceflights. These are just a few examples of brilliant female scientists that, as other male counterparts, made significant contributions to society but, unfortunately, were written out of history just for being women (Rossiter, 1982). This historical background of sexual discrimination helps explain why the figure of the scientist has traditionally been associated with the male gender.

Today, though, women are free to choose the professional career they wish, and yet the underrepresentation of women in STEM remains a social issue of widespread concern. Even if the female presence in these disciplines presents a slowly growing tendency, men still vastly outnumber women, especially at the top levels of these professions (Hill et al., 2010). Official statistics from 2019 and 2020 show that women make up only 29% of the STEM labour force worldwide and only 19% of STEM company board members are female, and as far as leading positions are concerned, the data is even more alarming, with only 3% of women occupying managing positions in these fields (Credit Suisse, 2019; United Nations, 2019; MSCI, 2020). Undoubtedly, this professional imbalance keeps “male” as the norm in the majority of scientific research, making it less diverse and competitive, and missing out on valuable innovations, ideas and perspectives of talented women with unique needs and desires. Still, STEM careers are not amongst the main preferences of women. A large and interdisciplinary body of research suggests that certain social and environmental factors have a strong influence on the career choices of both sexes (Hill et al., 2010).

The sociocultural heritage aforementioned, regarding the historical role of women in STEM, has unconsciously led societies to the adoption of gender stereotypes and popular false beliefs about what careers are suitable for men and for women (Nimmegern, 2016; OECD, 2017; Ertl et al., 2017). Some examples of these beliefs are that males are biologically better suited for scientific work than females, and that men are innately gifted for Mathematics, an assumption that has not been

supported by scientific evidence (Hyde et al., 2008; Penner & Paret, 2008; Fryer & Levitt, 2010). Gender stereotyping is inadvertently acquired since childhood, and may have an effect on future career choices of boys and girls, because when a child imagines holding a particular job as a grown-up, s/he first may wonder whether s/he is or not similar to the people that normally hold that job. According to data reported by the OECD (2017), career paths of boys and girls start to diverge at the age of 15, when boys are more than twice as likely as girls to picture themselves in STEM-related jobs as adults (p. 105). Moreover, more girls than boys experience anxiety and low self-confidence when performing Science and Maths tasks (OECD, 2015). It seems that the enduring lack of female role models in STEM reinforces implicit gender bias that continues to be passed on to new generations, becoming a kind of vicious circle that may justify this general disinterest and self-doubt in STEM amongst girls and women.

Another negative consequence that this association between men and STEM has for women is that these have often been trapped in what is called the double bind femininity-competence (Catalyst, 2007; Campus, 2013). Heilman & Okimoto (2007) noticed that when a woman is doing a traditionally “masculine” job, which is the case of STEM, she is often seen as either competent or likeable, but not both. If she emphasises stereotypical feminine communal traits of compassion, warmth and solidarity, she will have more chances to be liked but also to be considered less competent. Conversely, if she shows more stereotypical masculine agentic traits of assertiveness and self-determination, she will be regarded as competent but will be more likely to be disliked. As Corbett (2011) states, “both competence and likeability often matter in terms of professional advancement” (n.p), and women see themselves in a disadvantageous position, since it is only them who can be disliked when succeeding in a not usual working environment. The phenomenon of the double bind becomes even more noticeable when dealing with leading positions in STEM, since the traditional social image of a leader tends to take male characteristics for granted (Campus, 2013), so a woman will not show leadership unless she adopts typical masculine traits, where she will also risk being disliked.

Stereotypes are reproduced by a variety of silent and apparently innocent means, such as the media. In broadcast media, previous studies have shown that STEM female characters are underrepresented (Steinke, 2017; Davis & Coleman, 2018) and sometimes even nonexistent (LaFollette, 2013). In television shows based on fiction, whenever male and female characters hold STEM positions, they have frequently been depicted differently. Long et al. (2010) noticed that female scientist characters were less likely to be portrayed as independent and authoritative characters. Other studies have noted that fictional women characters holding STEM occupations in popular television programmes were often sexualised and depicted as incompetent (Bergman, 2012; Warren et al. 2016) or as secondary characters supporting male protagonists (Weitekamp, 2015). As Steinke et al (2007) hold, this construction, reproduction, and transmission of gender identities in STEM environments provide

negative messages about women and may unconsciously push them to choose different career paths even when they are talented in these fields.

In view of this background, the aim of this paper is to observe whether gender stereotyping in STEM is reinforced through another type of mediatic context: the Internet. For that purpose, I conducted a qualitative case study of eight crowdfunding project videos of science, an emerging online genre (i.e. text type) for public communication of science that provides depictions of real male and female scientists at their workplace. Through multimodal analysis, focusing on the verbal and visual modes of communication, I aim to address issues of identity, agency (i.e. capacity for socially meaningful action) and power, all of it in order to observe if there are any significant differences amongst both sexes that contribute to the perpetuation of gender stereotypes and biases in the scientific environment. This objective can be summarised in the following research questions:

- Are women researchers underrepresented in crowdfunding project videos of science?
- What roles do women and men adopt when communicating science and performing laboratory work?
- How are male and female identities constructed through verbal and visual meanings?

In the paper, I provide a detailed description of the crowdfunding project video: its background, context, and communicative purpose. I also explain the analytical approach adopted for the study of the verbal and visual content of the videos: the move analysis framework (Swales, 1990, 2004) and the Visual Grammar model (Kress & van Leeuwen, 2006). Finally, I discuss the extent to which gender stereotyping is reinforced through this multimodal text type, by supporting my findings with examples taken from the videos that make up this case study.

2. MATERIALS AND METHODS.

2.1. Emerging parascientific genres. The case of crowdfunding project videos.

Genre theory is a theoretical and analytical framework used in the field of applied linguistics that seeks to understand different types of communicative written and spoken texts and the sociocultural settings in which they occur, and it has been proven useful for the study of scientific communication in specialised contexts (Paltridge, 1995; Biber & Conrad, 2009). With the advent of digital technologies and the development of the Web 2.0, scientists have adopted new forms of text through which they can communicate their research to the general public (Luzón & Pérez-Llantada, 2019). The *Open Science* movement, or democratisation of science, intends to make scientific knowledge accessible to specialised and non-specialised audiences, so that the work of scientists is popularly acknowledged and supported (Nielsen, 2011; Boulton, 2012). Web-based communication allows the rapid

diffusion of information through multimodal texts that do not only rely on the verbal mode of communication (i.e., language) but on the visual (e.g. images, graphs, charts) and aural modes (e.g. music) through which scientists can convey their communicative intentions more effectively and creatively than with a single verbal mode (Hafner, 2018).

These text-types have been referred to as “parascientific genres” (Kaplan & Radin, 2011; Kelly & Miller, 2016), since they communicate specialised scientific knowledge with popular forms of discourse that can be accessible and understandable by people who do not necessarily belong to scientific communities. One of such parascientific genres, and the focus of this paper, is the crowdfunding project video of science.

Crowdfunding is an online practice whose goal is to collect small donations of money from a large number of people in order to carry out a project that needs funding (Mehlenbacher, 2019). It can be used by entrepreneurs of any kind, and it has become an ever more used strategy for scientists to raise capital for their scientific research. *Experiment.com* is one example of an online crowdfunding platform that hosts science-related fundraising campaigns. In this platform, scientists can create a crowdfunding page with detailed descriptions of the project in question (i.e. methods, purpose, budget, researcher’s profiles, etc.), and an optional promotional video where scientists have up to 3 minutes to explain their research idea and to convince viewers to donate to the cause.

Crowdfunding project videos enhance communication to diversified audiences and constitute a powerful tool for persuasion. As a result, they can contribute positively to the success of the campaign (Kim et al., 2016; Doyle et al., 2017; Greenberg et al., 2013). In the crowdfunding platform *Experiment.com*, researchers launching a campaign are encouraged to include a project video, as “projects with videos are 60% more likely to be fully funded, and are shared twice as much” (Experiment, 2021).

Videos are open to creativity in terms of audiovisual content. In most cases, we see scientists explaining what the project is about and providing arguments to defend why it should be funded. During those spoken narrations, they may overlap moving or standstill images of them working at the laboratory or specific research location where the research is being conducted. In order to persuade the audience, they need to construct competent and qualified identities to show that they are sufficiently prepared to carry out the research they need capital for and, consequently, that they deserve being funded. These identities are constructed by what they say, how they say it, and the image that they project to the public.

2.2. Data sources.

Unlike previous research on television shows mentioned earlier, I am dealing with non-fiction audiovisual material available on the Internet: real content and real

scientists, instead of actors and actresses playing the role of scientists. The data selected for the analysis are eight videos promoting crowdfunding campaigns related to the STEM disciplines of Biology, Engineering and Computer Sciences. In these videos, available in the platform *Experiment.com*, mixed-sex research teams participate to promote their corresponding projects to obtain funding and then be able to participate in an international synthetic biology competition called iGEM (International Genetically Engineered Machine), which is held annually. The participants of these videos are undergraduate university students from the United States and the United Kingdom competing in this contest from 2015 to 2019. The rationale behind this choice is to observe the current situation of women in STEM through authentic material elaborated by new generations of young scientists.

The following table provides a list with the titles of the crowdfunding campaigns associated with the videos selected, the year of release, the institution, and the number of male and female members belonging to each corresponding research team (as contrasted in the webpages of each iGEM team).

Table 1. List of crowdfunding project videos selected for the analysis

VIDEO	YEAR AND LOCATION	PROJECT TITLE	No. WOMEN/MEN RESEARCH TEAM MEMBERS
1	iGEM 2015- Yale University	“Can Bacteria turn Light into Fuel?”	5/13
2	iGEM 2016- Southern Connecticut State University	“Rapid Detection of Tuberculosis”	2/8
3	iGEM 2016- University of Michigan	“Developing a modular paper-based detection device for Tuberculosis”	5/11
4	iGEM 2016- University of Edinburgh	“The DNA Typewriter: Building a modular system to encode text in DNA”	5/4
5	iGEM 2017- University of Michigan	“Thermolyze: A Temperature Controlled Kill-Switch for Containment of Pathogenic Bacteria in Research Labs”	7/13
6	iGEM 2018- University of Tennessee	“Exploring the Bioremediation and Environmental Impact of Halogenated Organic Compounds”	4/11
7	iGEM 2018- University of Michigan	“CRISPR Cas9 testing model”	5/11
8	iGEM 2019- University of Michigan	“Paper-based detection device for spoiled milk”	8/8

2.3. Multimodal genre analysis.

Given the multimodal nature of these videos, a wide range of semiotic resources could be studied. However, taking the aims of this study into account, I only focused on the analysis of some verbal and visual resources. For the verbal content, I focused on speech: the spoken text covered by men and women. As for the visual content, I analysed the video footages showing scientists, the gaze of the scientists in those footages, the camera height from which scientists have been recorded, and the visual salience that each scientist is given with relation to other components of the image. In what follows, I describe in more detail how the selected semiotic resources are significant for interpreting the representation of male and female scientists in the videos.

Verbal content: Swalesian CARS model and move analysis

In order to study the verbal content of the spoken narratives covered by female and male scientists, I first identified the rhetorical structure of the videos by adopting the Swalesian “Create A Research Space” (CARS) model (Swales, 1990, 2004). According to this approach, a text can be segmented into “moves” or rhetorical units performing specific communicative functions that together construct the overall communicative purpose of such text. In other words, move analysis helps us understand how texts are organised to fulfil a communicative function.

For instance, in experimental research article introductions, Swales (1990, 2004) proposed the following three-move pattern:

- *Establishing a territory*, where researchers present the general context and theoretical background of the project.
- *Establishing a niche*, used to indicate a gap in literature or an experimental need in the field to justify the research.
- *Occupying the niche*, which reveals the final goals, procedures and possible results of the project.

Move analysis has been applied to a variety of academic genres such as research articles (Brett, 1994), academic abstracts (Salager-Myer, 1990) and grant proposals (Connor & Mauranten, 1999). With regards to crowdfunding discourse, it has been applied to the textual descriptions of campaigns appearing in online crowdfunding platforms (Liu & Deng, 2016; Mehlenbacher, 2017, 2019). In this case study, I aim to identify the rhetorical moves of crowdfunding project videos to observe the moves that are usually covered by male and female scientists. The purpose is to examine whether through the variable ‘gender’ any discrepancies are presented that may contribute to gender stereotypes in STEM.

Visual content: Kress & van Leeuwen's Visual Grammar model

Gender roles and identities in these videos are also constructed through the visual mode of communication, and for this, I followed the Visual Grammar model developed by Kress & van Leeuwen (2006), consisting in a social semiotic approach developed for the interpretation and study of images. This framework, based on Halliday's Systemic Functional Linguistics (SFL) theory developed in 1960 (O'Donnell, 2012), distinguishes three communicative "metafunctions" of the visual: representational, interactive, and compositional. The representational metafunction has to do with the representation of the world, its objects and subjects, by narrative and conceptual visual elements. It is related with SFL's experiential meaning, according to which reality is constructed by means of grammatical resources (verbs, nouns, prepositions and adverbs). The interactive metafunction intends to reflect the relationships between the participants of the communicative event, which can be portrayed by the camera shot, gaze, and other image acts. This is related with SFL's interpersonal meaning, expressed through grammatical mood and modality. As for the compositional metafunction, it is concerned with the visual arrangement of the elements of a text or image to convey meaning: it may have to do with the layout of a text for instance, or certain aspects of framing and salience of visual elements in the document. This one corresponds to SFL's textual meaning of the verbal message, which observes the way words and clauses are arranged to produce meaningful and coherent texts (Halliday & Matthiessen, 2004).

In terms of representational meanings, I observed the actions that researchers perform in the videos. According to Kress & van Leeuwen (2006), there are three types of participants in an action: the actors, or "doers" of an action; the goals, or receivers of an action; and the reactors, the ones that look at other people's actions.

Visually, participation is observed through "vectors", or visual elements that indicate an action (p. 46). For instance, in an image where a gardener is watering a plant and a child is looking at him/her, we would say that the gardener is the actor, the plant is the goal, and the child is the reactor. The vectors would be the hands of the gardener holding the watering can, and the gaze of the child looking at the gardener doing his or her job. In crowdfunding videos, this analysis is useful to observe agency, or the roles that female and male characters perform when working as scientists. In other words, whether they are actors (agents) or reactors (observers).

With regards to the interactive meanings, I analysed the semiotic resources of gaze and camera height to observe the relationship that researchers wish to maintain with the viewers. Kress & van Leeuwen (2006) state that if the participants look at the viewers (i.e., making eye-contact by means of direct gaze), the contact is established, and if the gaze is accompanied by a smile, the viewer is asked to enter in a relationship of social affinity with them. On the contrary, if the gaze is not addressed directly to the viewers (i.e., there is no eye-contact), no contact is made, and the participants pretend they are not being watched. The latter is normally the case in

film, television drama, and most importantly for this study, scientific illustration (p. 120), where a sense of disengagement with the audience is necessary for the participants to look credible and professional.

The camera height, for its part, is an interesting means of expression in cinematography that reveals power relations of the participants. If a character is filmed from a low vertical angle, s/he will be depicted as having power over the viewer, and the contrary would occur if filmed from a high vertical angle. If the picture is at the eye level, no power difference is involved amongst the participants (p. 140).

As for the compositional meanings, I studied how male and female characters are made more or less visible in the images through salience. According to Kress & van Leeuwen (2006), “the greater the weight of an element, the greater its salience” (p. 202). When an element is made more visible in an image, it is for viewers to pay more attention to it, to make it more important. This can be done, for instance, by placing the most relevant elements in the foreground, and the least important in the background. This dimension can also provide an insight into gender representations in crowdfunding videos of science, since it can be observed whether one gender or another are made more worthy of attention through this visual clue of spatial composition.

3. RESULTS.

In this section, I first deal with the verbal content through the moves identified, and then continue with the visual content by focusing on vectors, gaze, camera height and salience. To illustrate the findings, I also provide commentary on some salient examples. Some of the images included in these examples correspond to silent video footages accompanied by voice-over narrations.

Identification of moves

The main communicative goal of the crowdfunding project video is not very difficult to determine if we read the Researcher Guide of the platform *Experiment.com*: “to help win over backers through effective science communication” and to “convey the science behind a project to a wide audience” (Experiment, 2021). Namely, the purpose is to convince a diversified Internet audience to donate money for a scientific crowdfunding project. This purpose is conveyed by means of 8 rhetorical moves.

Table 2 lists these moves and provides a description and an example for each of them.

Table 2. Rhetorical moves of crowdfunding project videos of science

MOVE	COMMUNICATIVE FUNCTION	EXAMPLE
COMPETENCE CLAIM	Establishes the credentials of the researchers (institution, qualifications, experience, awards, etc.). The aim is to construct competent and prepared identities who deserve being funded.	“Our 2016 and 2017 IGEM teams here at UT, engineered an organism that was able to convert toxic waste into aromatic scent compounds that could be sold in the fragrance industry.” (Laurel, 2018)
GOALS	States the aims of the research project, and thus, justifies the need for funding.	“We’re using synthetic biology to help develop a means of better prevention and detection of tuberculosis.” (Quick, 2016)
BACKGROUND	Contextualises the research by providing information about its background, which also adds on the construction of a prepared identity, since the researcher also wants to show that s/he knows the research field well.	“The Lambda phage virus infects controls the lytic cycle by expressing two main proteins: holin and antiholin. An antiholin’s function is to decompose a cell wall resulting in cell lysis and the virus is able to spread.” (Bernstein, 2017)
RESEARCH PROBLEM	Exposes a problem in the territory or a gap in research that needs to be filled, so that it provides the justification of the study, or the necessity of carrying out the study.	“Each year, 186 pints of milk are wasted due to dairy spoilage. Dairy farms and companies often make their expiration dates far too generous in order to mitigate liability. Because of this, perfectly good milk often gets thrown away far too soon.” (Puri, 2019)
MEANS	Summarises or explains the materials, methods, or tasks necessary to achieve the research goals. It also shows the preparedness of the researchers.	“We have been preparing our own bubble breaks, and straining them to plasmons, and putting them up, and getting ready to do our First Assembly.” (Largey, 2016)
PROJECT SIGNIFICANCE	Claims the importance of the research project to demonstrate that it is worth donating for.	“By the end of the fall, we hope to have a testing platform that will be able to help other researchers improve the safety and efficiency of their genetic engineering tools.” (Stewart, 2018)
APPEAL FOR SUPPORT	Uses rhetorical strategies to solicit support from the funders and to encourage them to follow the research updates.	“So if helping people is something that you’re passionate about and you want to take part in our project, please donate to our cause.” (Chbihi, 2016)
GRATITUDE	Thanks viewers and ends politely.	“Thanks for your support!” (Lee, 2019)

The moves *Competence claim*, *Goals*, *Background*, *Research problem*, *Means* and *Project significance* have been adapted from previous research on research article introductions (Swales, 1990, 2004) and grant proposals (Connor & Mauranen, 1999), which suggests that crowdfunding project videos borrow most of its rhetorical structure from these traditional academic genres.

As for *Appeal for support* and *Gratitude*, they show more affinity with advertising discourse and promotional genres such as the philanthropic fundraising letter (Bhatia, 2004). The identification of rhetorical moves and their functions led to two interesting findings with regards to how gender differences in communicating science appear to be reflected in these videos. On the one hand, it was found that men cover most of the moves in these videos, so male scientists are made more visible than women through speaking time. On the other hand, those moves related to the establishment of credentials (*Competence claim*, *Project significance*) and the explanation of scientific phenomena and interpretation of data (*Goals*, *Background*, *Research problem*, *Means*) are covered by male scientists in all the videos, whereas their female counterparts perform those moves in which they ask for support (*Appeal for support*) and thank viewers (*Gratitude*); that is to say, women cover those moves that do not offer any significant information about the project or the credentials of the research team, but simply aim to establish a kind and intimate connection with the audience to convince them to donate.

Vectors indicating actors and reactors

The scenes depicting scientists working in laboratories or research workplaces show that both women and men are likely to appear as actors doing laboratory work (i.e., manipulating laboratory equipment, doing experiments, using a computer, etc.). Nonetheless, whenever male and female scientists appear working together within the same scene, the former perform the scientific work (are depicted as actors) while the latter look at what men do (are depicted as reactors). No examples of men represented as reactors of women's actions were found. Hereafter, I am providing some examples that help illustrate these findings.

In *Figure 1*, there is a scene where a male researcher is talking to someone on his right side (the vector emanating from his eyes and his arm gesture represents this action visually). The goal (the people to whom he is talking, or the receivers of the vector) cannot be seen. As for the two female researchers on the right side of the screen, they are not actors but reactors of the male researcher's actions (we also see that through the vector emanating from their eyes to the male researcher). A similar situation is depicted in *Figure 2*, where the male scientist is the actor as he is manipulating some laboratory equipment (the goal) while the female scientist is playing the role of the reactor or observer.

Figure 1- Actor and reactors in Video 6

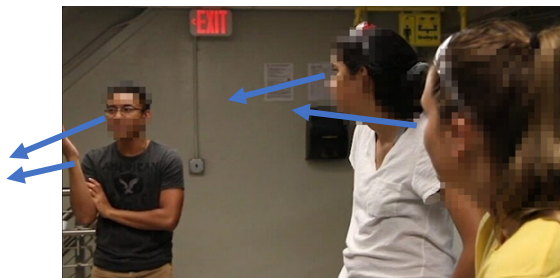
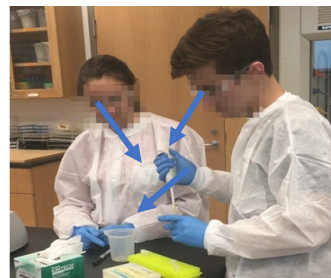


Figure 2- Actor and reactor in Video 7



The scene represented in *Figure 3* also illustrates different gender roles in the laboratory. During this video footage, two male scientists are performing the laboratory work: they are taking some materials out of what looks like an oven and placing them on a table. They do not make eye contact with their female colleague, not even when they are talking, as can be seen in the last part of the sequence. The female scientist remains as a reactor along the whole scene. She only looks at what they are doing and does not intervene in the action or in the talking. She does not even wear a white coat as her male counterparts do, which may suggest that she is disengaged from them and that she is not in charge of laboratory experiments.

Figure 3- Actors and reactors in Video 8



Interactions with the viewers: the gaze

When male scientists are engaged in laboratory experiments along the videos, they do not look at the camera, which means that they do not connect visually with the viewers. Instead, they pretend they are not being watched, making the scene look as if they had been caught by chance in the act of working. The images in *Figure 4* show male scientists in several videos concentrated on what they are working on, without addressing any direct gaze towards the camera.

Figure 4- Absence of direct gaze in Videos 3, 5, 6 and 8



The female scientists behave differently when recorded performing laboratory work. They do not pretend they are not being watched, quite the opposite, they engage with the audience not only with a direct gaze, but with a smile. The images displayed on *Figure 5* illustrate this behaviour, which is the opposite of what male scientists do (*Figure 4*.)

Figure 5- Direct gaze and smile in Videos 4, 5 and 7



Power relations: camera height and vertical angle

The camera height and vertical angle of recording is a visual element that contributes to the construction of identities and power relations. The analysis of angles in videos shows that scientists are normally recorded from an eye-level perspective, showing no power difference between them and the viewers. However, some examples show that male scientists are recorded from a low vertical angle, thus depicting them as powerful (see *Figure 6*). Interestingly, no examples were found of female scientists recorded from a low angle.

Figure 6- Low vertical angles in Videos 3, 5, 6, and 7



Female and male visibility through salience

When female and male scientists are recorded together in the same scene or camera shot, men occupy more space than women, and thus, the former are made more salient and visible than the latter. *Figure 7* illustrates an example of this compositional meaning. There are two male scientists and two female scientists appearing in the same shot. The man with glasses in the centre is the speaker (covering the moves *Competence claim* and *Research goals*) and together with the other male researcher, is standing in the foreground of the image. In contrast, the two female researchers are placed in the background, and they are also performing the role of reactors through the gaze directed towards the male speaker. Furthermore, men occupy most of the field of view of the camera and lean forward towards the viewers, while women are cornered on the right side of the image.

Figure 7- Male salience in Video 1



Male scientists' salience is also displayed in video footages where the whole team of researchers is pictured, because of the contrast between the number of men and the number of women. *Figure 8* depicts a scene where a team of scientists is working in a laboratory, with five men in the foreground against just one female

scientist in the background. As for *Figure 9*, it displays a group of 10 researchers, out of which 2 members are female, hence noticeably underrepresented.

Figure 8- Research team in Video 2



Figure 9- Research team in Video 4



4. DISCUSSION AND FINAL REMARKS

While this case study is based on a limited number of videos, it is nonetheless possible to draw some conclusions about the representations of female and male scientists through this parascientific genre, and into the effects that such representation may have on gender stereotyping and bias in STEM.

The small number of women belonging to research teams with regards to the number of men already shows that STEM disciplines tend to be androcentric fields, as men outnumber women in 6 out of 8 teams (See *Table 1*). This female underrepresentation is reinforced through speaking time and screen presence at shot level, since men cover most of the rhetorical moves that compose the spoken narratives and star the visual content. Apart from suggesting a possible gender imbalance in scientific work environments, these representations do not help reverse the harmful tendency mentioned earlier, as it does not make up for the lack of female role models in STEM disciplines. Therefore, if this trend persists, career choices of girls and women might continue to be influenced by gender stereotypes, as they may not see themselves identified with STEM-related professions.

In the videos, different identities are constructed by men and by women scientists. As shown in the videos analysed, male scientists are not only the protagonists, but they also adopt the role of experts and are depicted as powerful, confident and professional. Expertise is further suggested by the rhetorical moves that they cover during their spoken narratives: those moves related to the establishment of credentials and the explanation of scientific issues; namely, the smart topics. The fact that these contents are always addressed by men suggests that they are the authority of knowledge, as they look more prepared and competent than their female counterparts, who do not contribute to the communication of scientific knowledge in these videos. This finding is compatible with previous research on men's talk that states that bright subjects tend to be left to men, leaving "trivial" and less intelligent topics to women (Coates, 1996, p. 54).

In the same fashion, in this case study the male scientists have also proved to show their role of experts through agency. The visual representational meanings analysed imply that when they are sharing laboratory scenarios with women, men are involved in the action processes (manipulating equipment, doing experiments, or communicating), while women take part in the reactional processes, by simply looking at what men do. This distribution of roles when collaborating in an undertaking represent men as the competent individuals performing the executive role, and women as subordinate characters that remain, in Kress & van Leeuwen's (2006) words, as "faithful admirers of men's actions" (p. 67).

Speaking time, screen presence, and agency, are also consistent indicators of power, although not the only ones. A salient finding in this study is that the male scientists have been depicted as powerful through the low camera angle from which some male scientists (and not women scientists) are recorded in these videos, which makes the subject look "imposing and awesome" (Kress & van Leeuwen, 2006, p. 140). Moreover, power has also been conveyed by compositional meanings. The results of the analysis of visual salience have in fact shown that, when recorded together in the same shot, men occupy more space than women, and therefore are made more salient than women, drawing the viewers' attention to them.

Undoubtedly, these visual and verbal meanings do not transmit very positive messages about women's competence in STEM fields. In these videos, women adopt a secondary role with different characteristics than men. Whereas men generally show agentic traits of independence and self-reliance, women clearly emphasise communal traits of solidarity and kindness. As stated previously, the most representative semiotic resource proving these traits has been the gaze. Even if eye-contact and smiling can provide viewers with a positive impression, it feels as if they had been told what to do in front of the camera before being recorded, and they were looking for approval and sympathy from the viewers. It could also be interpreted as a gesture of embarrassment and insecurity. Whatever the case, it seems that through this behaviour, women feel the need to look gentle and sweet in front of the camera, to spark up positive relationship with the audience, to be liked. And even if likeability, as stated previously, is necessary for success, it can have a negative effect on competence when it is prioritised over agentic traits, as it has been explained before when dealing with the double bind femininity-competence.

The verbal content addressed by female scientists also seems to lend credence to their communal traits. As previously stated, the moves they cover are not actually related to scientific explanations that may show their preparedness and competence. Instead, they are rhetorical units that aim to show politeness and advocate for viewers to support their projects. Moreover, they appear at the end of the video, which makes women also appear at the end, after men have elaborated on the moves that contain relevant information about the project.

This secondary role has also become evident when analysing speaking time, screen presence and salience. Not only are they less visible than men, but also look

passive and silent when a man is sharing the same scene with them. As previously shown, female scientists only adopted the role of actors when they were alone. While engaged in laboratory experiments, they seemed to be more concerned about being liked than looking professional in front of others. Also, when they are filmed within the same context with male scientists, the latter do the job and the former do not intervene and remain as reactors, from which one may surmise that they were learning from their male colleagues, feeding the role of experts that these intend to play. This acceptance of a subordinate role from women in STEM research environments could be due to an unconscious lack of self-confidence and sense of belonging to the STEM research community, although future research is needed to further validate this claim.

Finally, it is worth noting the implications that derive from the fact that the little interventions of female scientists in these videos are in contrast with the overt display of competence and professionalism of their male counterparts, reinforcing the false belief that STEM are male fields. If a matter of growing concern is to close the gender gap by encouraging girls and women to pursue scientific careers, more equitable participation and representations are needed through the media and digital genres like the crowdfunding project video.

The fifth of the 17 sustainable development goals (SDGs) set by the United Nations General Assembly for the 2030 Agenda is to “Achieve gender equality and empower all women and girls” in all private and public spheres (United Nations, 2015, p.14). Regarding the gender gaps in STEM, it is stated that “is not the result of innate ability but rather due to the socialisation process including gender stereotypes (...) Thus, addressing under-representation of women in STEM requires an accelerated holistic approach” (United Nations, 2020, p.1). This is why, in order to empower women and encourage them to choose scientific careers, successful female role models around them are a must and the contents of science-related videos like these should be chosen carefully.

The results of this research present some limitations and lines for future research. Firstly, this case study focuses on videos for the iGEM research competition, and the fact that I found gender and STEM stereotypes reinforced through them does not intend to suggest that this behaviour can be generalised to all crowdfunding project videos of science.

Secondly, it would be useful to combine this multimodal analysis with ethnomethodological tools for analysis, such as interviews and focus groups, that would give us an insight into females’ own perception as researchers when engaging in parascientific communication to target diversified audiences.

Lastly, it would be interesting to compare these results with others in future videos for the iGEM competition, in order to check if there is a pattern in gender representations, and hopefully, this paper can shed light in that direction.

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