Revista de Comunicación y Salud, 2019, Vol. 9, nº 2, pp. 55-70
Editado por Cátedra de Comunicación y Salud
ISSN: 2173-1675

Enviado 19/11/2019
Aprobado 20/12/2019

NEW DIGITAL COMMUNICATION TOLOS BETWEEN HEALTH PROFESSIONALS AND PATIENTS.

ABOUT THE DEJAL DEJAL@BOT PROJECT

Nuevas herramientas de comunicación digitales entre profesionales de la salud y pacientes. A propósito del proyecto dejal@bot

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Resumen

La comunicación es una habilidad humana que permite relacionarnos; construir nuestra identidad (individual, grupal y colectiva); compartir normas, hábitos y conductas e ir evolucionando personal y socialmente a partir de la creación, desarrollo y adquisición de nuevos conocimientos y habilidades. La comunicación en salud es especial por la asimetría entre el sanitario y el paciente. Su objetivo es curar, prevenir enfermedades o potenciar aptitudes y actitudes saludables. Su base (anamnesis) es muy concreta. El paciente expone su motivo de consulta y el sanitario obtiene datos que orientan la exploración para obtener un diagnóstico y tratamiento. La aparición de herramientas digitales para comunicarnos está modificando esta relación debido a su comodidad e inmediatez, ambos aspectos muy apreciados por la población, y los sanitarios no podemos permanecer ajenos. Las innovaciones tecnológicas se desarrollan a mayor velocidad que los ajustes en materia de ética y legislación ¿Qué ocurre cuando uno de los sujetos del acto de la comunicación no es humano? Se define chatbot como un robot conversacional que integra un sistema experto o inteligencia artificial que permite una conversación con un humano. El desarrollo de chatbots en salud todavía es escaso, pero va a ser una herramienta cada vez más habitual en los próximos años por su gran eficiencia, planteando retos tecnológicos, sociales, éticos, comunicativos y

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sanitarios. El proyecto Dejal@Bot es el primer ensayo clínico independiente y realizado en Atención Primaria de Salud para ayudar a los pacientes a dejar de fumar asistidos por un chatbot. Ello ha generado problemas de comunicación humano-máquina reflejados en éste artículo.

Palabras clave: comunicación, salud, chatbot, inteligencia artificial, sistemas expertos, big data.

Abstract

Communication is a human ability that allows us to relate; build our identity (individual, groupal and collective); share norms, habits and behaviors and evolve personally and socially from the creation, development and acquisition of new knowledge and skills. Health communication is special because of the asymmetry between the professional and the patient. Its objective is to cure, prevent diseases or strengthen healthy attitudes and aptitudes. Its base (anamnesis) is very concrete. The patient sets out his reason for consultation and the healthcare provider obtains data that guides the exploration to obtain a diagnosis and treatment. The emergence of digital tools to communicate is changing this relationship for their comfort and immediacy, aspects highly appreciated by the population, and the healthcare providers cannot remain outside. Technological innovations develop faster than adjustments in ethics and legislation. What will happen when one of the subjects of the communication act is not human? A Chatbot is defined as a conversational robot that integrates an expert system or artificial intelligence that allows a conversation with a human. The development of health chatbots is still scarce, but it will be a more and more usual tool in the coming years due to its great efficiency, posing technological, social, ethical, communicative and health challenges. The DejaloBot project is the first independent clinical trial conducted in Primary Health Care to help patients quit smoking assisted by a chatbot. This has generated human-machine communication problems displayed in this article.

Keywords: communication, health, chatbot, artificial intelligence, expert systems, big data.

Cómo citar el artículo
Ávila-Tomás, J. F., *et al.* (2019). Nuevas herramientas de comunicación digitales entre profesionales de la salud y pacientes. A propósito del proyecto Dejal@Bot. *Revista de Comunicación y Salud, 9*(2), 55-70.
doi: http://doi.org/10.35669/revistadecomunicacionysalud.2019.9(2).55-70

1. EL APRENDIZAJE DE LAS MÁQUINAS. COMUNICACIÓN ENTRE EL HOMBRE Y LA MÁQUINA

Machines can learn in a similar way to humans through repeated exposure to situations with similar solutions. Experience leads us to make decisions that have previously been useful in solving similar problems in our past, generating abstract solutions from concrete everyday elements. similar problems in our past, generating abstract solutions from concrete everyday elements. It is operant conditioning, one of the principles that governs our behaviour, where behaviours that bring a benefit are more likely to be repeated.

In other respects, however, there are differences between human and machine learning (Lake, 2015):

1. Human learning is dynamic and changing depending on the context and life circumstances. There are events that occur during childhood, in maturity or in old age, and may occur in the context of illness, life crises or special life situations that will condition our learning.
2. It is variable from person to person: there are individuals who have been exposed to many life events while others have a life with fewer life experiences. There are also qualitative differences, as different people, faced with the same life event, may have different experiences.
3. We can expose machines to simulated or real situations that would be ethically impossible with humans.
4. The speed of data acquisition by a machine is faster. The machine has no other functions (food, rest or leisure) and is not exhausted (it works 24 hours a day).

Decision-making can be represented by logical algorithms that can be translated into a language interpretable by machines. The relationship between Big Data and Artificial Intelligence is that these huge amounts of data in multiple formats (Big Data) are used to train and equip a machine with the expertise to develop and train autonomous decision-making algorithms (Obermeyer, 2016).

Let us imagine that a machine "knows" all the content that has been published in health in the last 10 years, that it is equipped with logical tools that allow it to establish relationships between them and that it is capable of moving from a specific case to a global one. We would then have a more reliable diagnostic decision-making tool than the best doctor in the world, as none will be able to handle all the variables as quickly and accurately as computer systems do.

We can distinguish two types of learning (Isasi, 2004) applied to machines:

1. Supervised learning. With human participation, which determines the "right" and "wrong" relationships of the machine. The human function is to "reinforce" successes so that they tend to be repeated
2. Machine learning. This consists of feeding the machine with experience (from Big Data) and making it, by means of initial logical rules, capable of learning independently from the experience provided by the data without continuous human assistance.

There are numerous examples of Machine Learning based on logical structures arranged in complex layers (somewhat similar to the interconnection of neural networks). Many of these layers are "specialised" in specific topics, such as neurons, with layers specialised in "seeing", "listening" or "relating" (Julián, 2016).

These processes are not explained in an exclusively mathematical way, as initial learning patterns are established (basic neural skeleton) that are modified and improved through experiences provided by Big Data and generating their own "neural connections". In a short time, and with a sufficient amount of data, we can have a specialised system capable of making decisions.

The use of robotic systems in healthcare poses a problem in human-machine communication. The robot must express itself in a way that users can understand, and it must interpret what those users express without having to do so in a different way from how they would communicate with another person. In short, the aim is to imitate human beings in the way they interact (Alonso Martín, 2014).

The development of anthropomorphic robots for the direct care of people can produce rejection in humans when interacting with a machine with a humanoid appearance. This is the so-called uncanny valley theory, named after the definition of "the unsettling" from the essay "On the psychology of the unsettling" by Ernst Jentsch (1906). "The unsettling is a disturbing sensation in the presence of something that is both familiar and unfamiliar at the same time. A situation or object that is very similar to something everyday and well known, but which causes us discomfort. This theory is taken up by Masahiro Mori in 1970 to describe the human/robot relationship, which is increasingly positive as long as the robot maintains the appearance of a robot and we are aware that it is a machine at our service. When the robot acquires anthropomorphic features, the emotional response of a human will be increasingly negative, to the point of rejection due to the "unease" generated.

This theory can be explained in the following way (Alonso, 2014); if an entity is quite different from a human, its characteristics will be highlighted, and will generate sympathy; whereas if the entity is human-like, its "differences" will be evident, and may create feelings of rejection (figure 1).

1. A robot with a human appearance can act on our subconscious by generating the idea that every human being is a mechanical element lacking a soul.
2. If most androids are copies of real people they become doubles, causing fear of being replaced.
3. The clumsiness of the android's movements could generate rejection by provoking fear of loss of body control.
4. The existence of androids may be perceived as a threat to the concept of human identity.

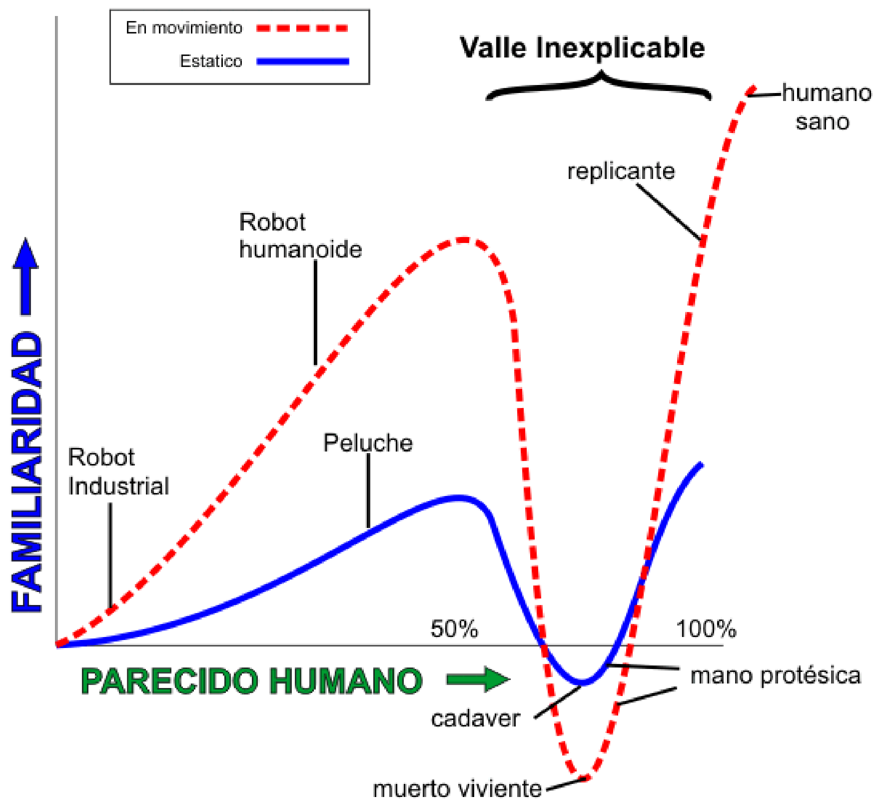

Figura 1. *Representación del "valle inquietante" descrito por Masahiro Mori.*
Fuente: Imagen original de Edgar Talamanes.
https://es.wikipedia.org/wiki/Valle_inquietante#/media/Archivo:Valle_inexplicable2.gif

However, it does not always generate rejection. Researchers such as Hiroshi Ishiguro, director of the Robotic Intelligence Laboratory at Osaka University, has created his own robotic clone with artificial intelligence that acts as a double of its creator in the Geminoid project.

This project (Ishiguro, 2019) goes beyond the gimmick of creating clones by developing lines of research into the human-robot relationship in search of the concept of what it is to be "human" and studying the interactions both from the point of view of personal and social influence on humans and the modifications that are generated in artificial intelligence.

2. PROYECTO DEJAL@BOT

The Dejal@Bot project was born in 2014, when a group of doctors related to the Sociedad Madrileña de Medicina de Familia (SoMaMFyC) belonging to the Grupo de Abordaje al Tabaquismo (GAT) and the Grupo de Nuevas Tecnologías (New Technologies Group), decided to evaluate the impact of technological tools on smoking cessation in our patients. Technologies Group, we decided to evaluate the impact of technological tools on smoking cessation in our patients.

In a review of published clinical trials, we saw that there were articles referring to support with SMS messages and some mobile applications (apps). After evaluating the main apps, none of them adapted to the guidelines set by the scientific evidence through clinical practice guidelines, so we set out to build our own. The cost was considerable and we turned to public funds by applying for a FIS (Health Research Fund) grant in 2015. This grant was denied and the project was put on hold for a few months.

We were satisfied with the chosen methodology and believed in the relevance of the project as there were very few clinical trials in digital health and products were being marketed without prior demonstration of their benefits.

We worked for a year and during that period of time the application of artificial intelligence in health started to be discussed. The first chatbots in healthcare appeared and we came up with the idea of using a chatbot instead of an app. We reformulated the application and applied to the 2017 FIS call where we were awarded the grant.

Smoking is the leading cause of disease and preventable death in the world, directly causing 5 million deaths per year (WHO, 2012). In Spain, 24% of the population smokes daily, and a further 3.1% are occasional smokers (INE, 2013), which caused nearly 52,000 direct deaths in 2014. (Ministry of Health, 2016)

Most smokers would like to quit, and the percentage of smokers who try to quit is high (up to 78 attempts per 100 smokers over one year in the UK), but only 2-3% remain smoke-free one year later. (Averyard and West, 2007)

Healthcare professionals are very effective and efficient when we intervene with smoking patients, more than tripling their chances of abstinence. However, only 1 in 20 attempts are made with professional supervision. The factors causing these low intervention rates are the training deficit of professionals, their belief in the low usefulness of the intervention and the perceived lack of time to carry it out. (Saito, 2010)

Therefore, we believe that the existence of a tool that is easy to use, accessible via a mobile phone and has the knowledge of a smoking "expert" could play a role in the smoking cessation process.

Bot technology on mobile devices has several advantages over the usual applications (Apps):

1. A chatbot is not a programme that needs to be installed and does not take up space in the phone's memory.
2. It respects the privacy of the patient/user without access to personal data.
3. It does not require training as communication takes place via a messaging app (the most widespread application among mobile phone users).
4. Uses a standardised interface favouring usability and adherence.

Our bot has been designed integrating behavioural, motivational, problem-solving and relapse prevention components, structured in interventions of proven usefulness to help quit smoking and recommended in evidence-based clinical practice guidelines (NICE, 2008).

We invite readers of this article to learn about this independent project through our website (www.dejalobot.es) where we generate content related to the project in open access to promote other similar projects that may be underway.

This is a randomised clinical trial designed to demonstrate the effectiveness of a conversational bot for a fundamental preventive aspect in the treatment of citizens such as smoking cessation. This study has been funded by the Fondo de Investigaciones Sanitarias Instituto de Salud Carlos III under the number: PI17/01942 and the European Regional Development Fund (ERDF).

The funders played no role in the design of the study, the collection of data during the fieldwork or the interpretation of the data.

The fieldwork involved 252 collaborating researchers, primary care health professionals from 36 health centres in the Community of Madrid.

The fieldwork began in October 2018 and will continue until the end of November 2019, with 540 smokers, who were randomised to the control arm (face-to-face smoking cessation in the consultation room following the existing protocols for this intervention) or to the intervention arm, and in which, after an initial visit for inclusion and initial assessment, they downloaded a regular commercial messaging application onto their mobile phone through which they interacted with the chatbot that would guide their smoking cessation process. The intervention scheme can be seen in figure 2.

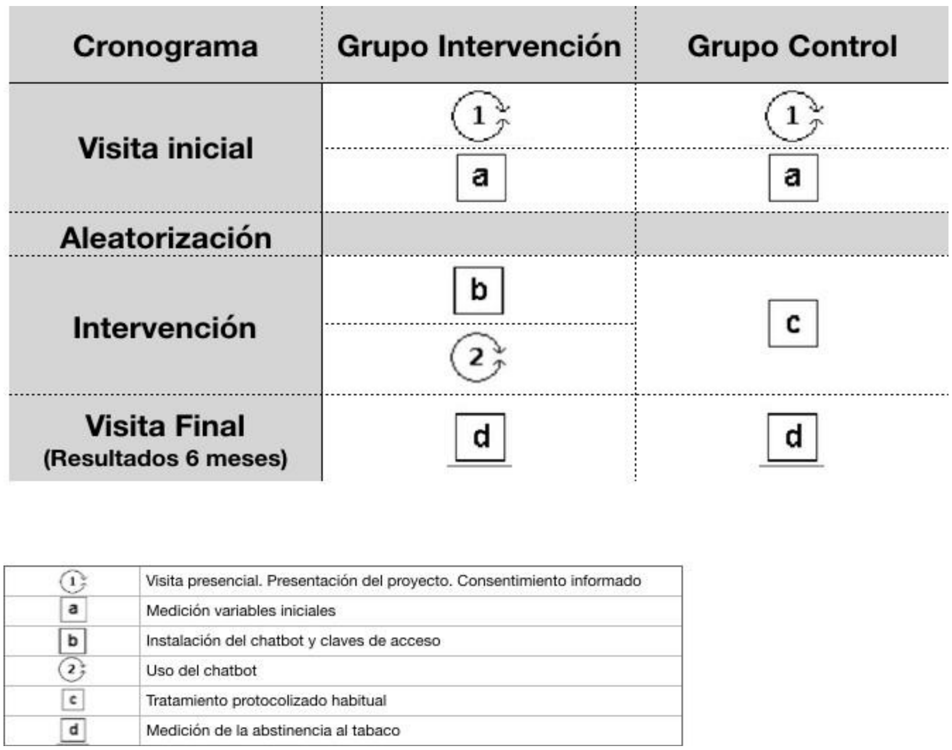

Figura 2. *Pat Plot del ensayo clínico Dejal@bot.*

The primary variable is abstinence at 6 months, reported by the smoker and biochemically verified through co-oximetry. Secondary demographic variables of participants and researchers, quality of life variables and variables related to the efficiency of the process have been measured.

This study was approved by the Clinical Research Ethics Committees of the Community of Madrid (13 December 2017) and of the Hospital Universitario 12 de Octubre de Madrid (Madrid, 30 January 2018) in compliance with Spanish legislation on human experimentation and respecting all bioethical principles of autonomy, justice, beneficence and non-maleficence, in accordance with the standards of good practice of the Declaration of Helsinki and the Oviedo Convention.

We are currently finalising the fieldwork and do not have definitive results. We are grateful for the methodological support of the Fundación para la Investigación e Innovación en Atención Primaria (FIIBAP) from the initial conception of the study.

The clinical trial protocol has been accepted for publication by the journal BMC Medical Informatics.

The methodological design of the work has been a challenge, but a greater challenge was to design a chatbot with "human" communicative features that in the intervention arm of our trial would offer advice, support, information, information, and support to the patients.

The methodological design has been challenging, but more challenging was to design a chatbot with "human" communicative traits that in the intervention arm of our trial would offer advice, support, information and reminders, establishing a communication with a human that either of us could initiate through natural language.

3. COMUNICÁNDONOS CON NUESTRO BOT

Communication with the bot takes place in different ways::

1. Communication through written text. A chatbot works through dictionaries of concepts or ideas that are trained through common words or phrases that describe the same concept or idea. These dictionaries are grouped by semantic fields that establish a series of categories. In our case, we established a series of categories related to the different stages, feelings or processes related to smoking cessation. Thus, we created a category we called "reasons for quitting smoking" with the following semantic fields: "health/fear/illness", "money", "exemplary role", "aesthetics", "self-esteem/freedom". Within each of the fields we grouped a series of ideas, words or concepts with which a given situation is usually expressed, thus creating an initial dictionary. Thus, in the case of the "aesthetics" field, we include concepts such as "yellow teeth", "bad breath", "wrinkles", "I'm getting old", "I'm getting old", "I'm getting old", "I'm getting old", and so on up to 20 initial concepts.
   When the bot goes to a category/semantic field/dictionary and "does not find" the word or concept but thinks it must be there, a warning is sent to the programmer asking if the phrase written by the human corresponds to a specific category. If the programmer answers in the affirmative, the bot includes the new word or phrase in the corresponding dictionary. In other words, with continued use, the bot learns and completes each of the dictionaries. If not, it is the programmer who places the concept in question in the corresponding dictionary so that the bot "learns" new synonyms and delimits each of the dictionaries.
   Our bot has 20 categories, 235 semantic fields and it started with more than 10,000 concepts in its dictionaries.
   As a curiosity, we have created a category "swear words" to generate a response to the interlocutor who uses them, such as "don't talk to me like that, I'm a small robot and I don't like swear words" or "don't get angry, it's not that bad".
2. Communication through emoticons: When using a communication through a chat and due to the large use of emoticons in this communication channel, we decided that the bot should use them within a text language. Thus, we created a series of categories that defined the moods expressed by each of the emoticons, so that it could use them within its dictionaries to express a specific emotion or situation.
3. Multimedia communication: Through a chat system we can share files in different media that can be executed or reproduced without the need to leave the programme. In this way we have produced 17 videos and 20 infographics that offer information that would be difficult to express in text.

Communication with a bot is bidirectional and can therefore be initiated by the human (reactive bot) or by the machine itself (active bot).

The first interaction is active, generated by the bot:

“"PRESENTATION OF THE BOT AND THE PROTOCOL
B: Hello, human being! How are you? Welcome!
B: My name is Dej@lo Bot and I am going to be your assistant to help you quit smoking. B: I have been programmed by smoking experts following the latest scientific guidelines to help you and accompany you throughout this process.
B: I will be with you at all times. Just call me if you need me.
B: My approach is simple. I follow a formal programme to help humans to stop smoking similar to the one used in the best specialised clinics. I will go through it with you two weeks before quitting and several months after.
B: Today I will ask you some questions, and the following days I will give you homework and advice. The tasks are not compulsory, but humans who do them greatly increase their chances of quitting smoking, as they help you to anticipate and solve the most common problems that arise.
B: To motivate you to work, I will give you a series of badges that give you access to higher levels of the process if you complete the main tasks".

The bot has the following communication actions active:

1. On presentation or activation of the bot.
2. In each of the phases determined by the research team. According to scientific evidence, a series of tasks must be carried out prior to the quit date in which the smoker's situation is explored and knowledge is offered (attitudes towards cravings, attitudes towards potential relapses, how to handle cravings, how to draw up a list of reasons for quitting, exploration of existing myths related to smoking...). These activities should be carried out on specific days and before the "D-day" or date determined by the smoker as the first day without tobacco. Depending on the concepts we want the smoker to learn, the bot behaves actively on days determined by the researchers and at a time chosen by the smoker.
3. After "D-day", the bot has daily contact for the first three days, then every other day, then weekly and finally monthly.

Reactive communications occur when the smoker initiates communication through the chat and answers are provided to the questions the human asks.

"REACTIVE MENU (when the patient enters of his own accord at any time)

F: "-"
B: Hello human! How can I help you?
B: If your question matches any of the possibilities I offer below, please tick the corresponding option. If not, tell me about it in a clear and simple way.
F: (develop semantic fields)".

4. COMPENSACIONES Y RECOMPENSAS

In behaviour change interventions, the establishment of "rewards" or pleasant situations that enhance any positive changes made by the patient is of great importance. In this way, we use operant conditioning to our advantage, trying to ensure that the behaviour identified as positive also has beneficial effects in the short term.

Gamification is the use of techniques, elements and dynamics of games in non-recreational activities in order to enhance motivation, reinforce behaviour, improve productivity or facilitate learning (Deterding, 2001).

With these conditions, we have established systems of rewards and prizes, generating a layer of gamification within the bot. These activities are also forms of communication between the human (patient in the process of quitting smoking) and the machine.

1. Badges: Badges are awarded as a series of activities or milestones are achieved throughout the process, especially in the first part, from the first connection with the bot to the "D-day" (or first smoke-free day). We have chosen a 5-star system (similar to the rating systems in many web services) to which the user is accustomed. These stars are awarded when the smoker completes a series of tasks essential to the process such as: making a personal list of reasons for quitting, determining the D-day or selecting a trusted person to call in case of a crisis.
   The badges are a series of rewards that mark the evolution of the process and distinguish a user from the rest of the community for the achievements obtained.
2. Other rewards: On the first day of contact with the bot, the user is asked what their favourite music group is and this is checked (figure 3). This data is not used again for several weeks but is stored in the chatbot's memory. From "D-day" onwards, at each new connection, the first question the bot does not ask is "have you smoked since the last time we talked?", if the answer is "no" the bot randomly gives us a YouTube video of our favourite artist. If the answer is "yes" it explores the reasons why we have relapsed and offers us the possibility of marking a new "D-day" when we are ready for it again.

Figura 3. *Pantallazo de diálogo real del chatbot en el primer día cuando explora y comprueba nuestro grupo musical favorito.*

5. HUMANIZANDO NUESTRO BOT PARA MEJORAR LA COMUNICACIÓN

Using a chatbot that communicates with a human being through a conversational application and that allows a dialogue using multimedia elements (text, images, videos) avoids the so-called uncanny valley because, although the human is aware that he or she is talking to a machine, the machine does not have a human appearance.

The process of quitting smoking is a personal decision that affects our intimate level and having a machine as an interlocutor could mean a cold and unpleasant or impersonal communication for the user of this tool.

Humanising technology is a challenge in an environment where we have more and more tools to carry out these actions, as technology must be at the service of human beings and not at the service of its products (García Avilés, 2008).

Así, Thus, we sought to give the bot an image without detaching it from its machine character; we wanted to humanise our corporeal robot.

Within the cinematographic culture of the 20th and 21st centuries we have examples of the humanisation of robots. Aggressive aspects like in the films Terminator (Cameron, 1984) or Robocop (Verhoeven, 1987); with feelings practically indistinguishable from humans like in the film Blade Runner (Scott, 1982); childlike aspects like Wall-e (Stanton, 2008); or robots that relate to each other like C3PO and R2D2 in the different film episodes of the Star Wars series (Stars Wars 1977-2019).

We wanted an image of a robot close to human passions while still looking physically like a robot, and in our search we discovered Bender B. Rodriguez, a robot from the series Futurama (FOX 1999-2013).

In Futurama, robots represent beings without ethical constraints, which allows them to occupy a dastardly and miserable place in society, even though they are a full part of it. By using an "unfamiliar" element such as robots, we can show us "something familiar" such as human flaws, channelled through Bender.

We searched for copyright-free images to use in our project and through different vector models we generated our Dejal@Bot. (Figure 4):

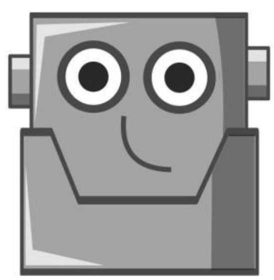

Figura 4. *Aspecto original de Dejal@Bot.*
Fuente: Elaboración propia a partir de imágenes vectoriales libres de derechos.

We had to endow it with human feelings, as we wanted it to be a robot that would accompany the human in the process of quitting smoking and that would go through the same emotional situations as the human. The best way we currently have to show feelings graphically in chat environments are the so-called emoticons, which have established themselves as standards in their meaning as elements of communication.

The next step was to create facial images to represent these moods. (Figure 5):

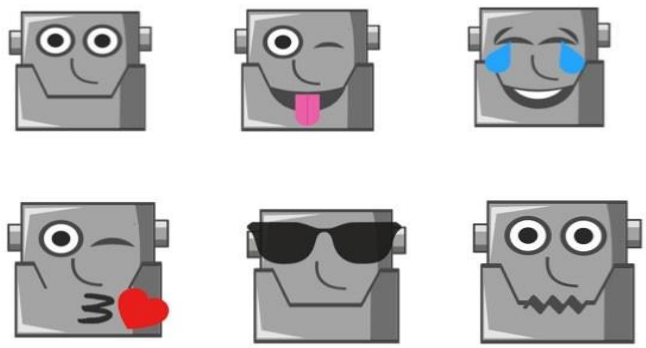

Figura 5. *Diferentes imágenes de Dejal@Bot para representar estados de ánimo.*
Fuente: Elaboración propia a partir de imágenes vectoriales libres de derechos.

However, the great technological challenge has been to establish a set of semantic fields of concepts to be able to establish communication between human and machine through a natural language capable of including the great variability of existing expressions to describe different moods in the process of quitting smoking. The work for them has been enormous and difficult to describe.

Currently, the Bot is in a process of continuous improvement where the opinions of its users have great weight.

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