

# Looking for the minimal qualities of expressive movement in a non-humanlike robot

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**Abstract.** We tackle the issue of expressive movement in non-humanlike robots, conducting a study with the goal of providing a characterization of expressive qualities embedded in the movements of a simple robot. We provide evidence that expressivity can be considered as a distinct modality of evaluation, distinct from other ways to consider a movement. Our first results indicate that expressivity is primarily associated to movements possessing a form of granularity and readability.

## 1 INTRODUCTION

What is an expressive movement? A colourful movement? A meaningful movement? A movement that carries aesthetic properties? Like all attributes that partake of cognitive and social qualities (What is beauty? What is justice?), expressivity may be easier to recognize than to define. As we may easily sort out an expressive from an inexpressive behaviour, we may struggle to determine on which behavioural aspects our judgment is based.

In the framework of nonverbal communication, expressivity may be considered one of the possible communication channels humans can navigate through. From that perspective, expressivity can be equated to the channel conveying information about the intensity, rather than the content, of a nonverbal message: the ‘how’ vs the ‘what’ [1]. While raising an arm may signal, for instance, the willingness of a student to answer a question (the content of the message), the speed or amplitude of the gesture may indicate a degree of agitation or eagerness (the expressivity of the gesture). Here we can distinguish a general movement pattern (e.g. raising one arm above the head) that encodes a shared meaning [2] from expressive variations that, although not directly participating in the content of the message, transmit nuances about the intended message.

Expressive variations in general movement patterns are also apt to reveal information about the characteristics of the messenger, that is to reveal idiosyncratic information [2]. An expressive movement can be considered one that transmits a particular emotion, an attitude, or a general disposition to act and react in certain ways [3,4]. Studies investigating the expressivity of behaviour in relation to idiosyncratic information typically look to identify the combinations of gestures and postures, as well as behavioural patterns, that convey a specific emotion or attitude [5,6,7]. This domain of research has applications in the automatic recognition of affects [8,9] and the design of robots that look to reproduce human expressive gestures [4].

The two major accepted meanings of expressivity: expressivity as information about the intended message, and expressivity as

information about the messenger, are both reliant on the configurations allowed by the human body to generate meaningful expressions. Yet, there are reasons to think that expressive qualities can be at least partially abstracted from specific body expressions related to attitudes and emotions. The literature on robot expressivity, while often focused on the replication of human postural and gestural expressions, proves at least that a biological body is not a necessary condition to perform an expressive motion [10,11]. Moreover, studies investigating the expressive movement associated to dancers or musicians performers suggest that expressive qualities exist beyond the constraints of nonverbal communication. First, most dance movements have no goals or objectives other than to transmit a certain expressive content [12]. Although they may convey an emotional content, they are not completely correlated with the representation of specific emotions or attitudes. Second, the fact that expressivity can be conveyed with other modalities than vision [13] is an argument in favour of the existence of expressive patterns abstracted from body expression and possibly multimodal. Recently the domain of non-humanoid robotics has proven a promising field for the exploration of expressive qualities [14]. Robots that bear no resemblance to humans (or even animals) explore modes of expression that rely on the psychological attributions triggered by their behaviour [15]. Deprived of the features deemed essential to nonverbal communication (a human-like or animal-like morphology), they harness a form of expression carried almost exclusively by movement attributes [16].

## 2 METHODS AND RESULTS

As a preliminary attempt to tackle the issue of expressive movement in non-humanlike robots (and more generally the nature of expressive movement itself), we conducted a study with the goal of providing a characterization of expressive qualities embedded in the movements of a simple robot. Is expressivity a specific channel in the communication of non-verbal information? To what extent is it related to other ways of qualifying a movement? Expressivity is often considered in the context of effort, such as in Laban movement analysis [17], where effort represents a specific component of the system and is associated to the subtle qualities associated to the inner motivation of a movement. Expressivity is also often associated to an increase in the quantity of bodily movement [18], such that a behavior considered more expressive may also be characterized by a higher level of activity. Is there a direct relationship between movement quantity and expressivity? Is there a strong association between expressivity and the sense of effort imparted by a perceived movement? To answer those questions, we devised an experiment in which variations in a

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robot's movements had to be evaluated according to different criteria. We were especially interested in determining whether expressivity is correlated to the overall activity perceived in a robot's behaviour. We also wanted to test if expressivity is directly linked to internal attributes, such as effort or discomfort. We constructed a robotic structure that we animated with oscillating patterns varying in terms of speed and amplitude. Using the MisbKit robotic toolkit<sup>2</sup> (<http://misbkit.ensadlab.fr>), we devised a structure composed of two motors linked together with a flexible plastic rod (Fig. 1a), as well as two leather strips positioned laterally to consolidate the structure. We then wrapped the structure into a thin white fabric to hide the mechanism (Fig. 1b). When a motor is actuated, the structure undulates, producing contractions similar to those produced by a caterpillar. Depending on their amplitude and velocity, those movements may evoke a calm respiration, or more dramatic contortions when the motor rotation is increased. The motor was animated with a sinusoidal movement, with variations in the motor's speed of rotation and amplitude of rotation. From the robot's motion, we produced 6 ten seconds long video sequences (<https://youtu.be/DfoxcqWtVfk>) resulting from the combination of 3 rotation velocities (low, medium and high speed) and 2 rotation amplitudes (low and high amplitude).

20 participants were recruited from Ensadlab students with the task to watch the 6 sequences and rank these sequences, from the most representative to the least representative of the following criteria:

- a) the robot is active
- b) the robot is making an effort
- c) the robot's movements are regular
- d) the robot feels discomfort
- e) the robot's movements are expressive

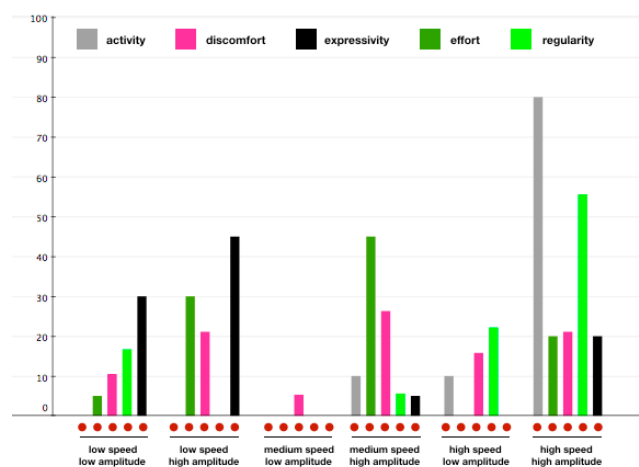


**Figure 1.** A simple robotic structure to evaluate the expressive qualities of movement.

Comparing the rank attributed to the sequences according to the criteria, we could determine whether the rank based on

<sup>2</sup> The MisbKit has been elaborated by the Reflective Interaction research group (<http://reflectiveinteraction.ensadlab.fr>) for the purpose of quickly prototyping animated structures in the context of workshops.

expressivity correlates with the other ranks. Our first results are in favour of considering expressivity as a modality of evaluation distinct from the others (Figure 2). We did not observe a significant correlation, positive or negative, between the way people rank the sequences according to expressivity and the way they rank the sequences according to the other criteria. In other words, when they evaluate the expressive nature of a movement, participants do not elaborate the same classification as when they consider activity, regularity, effort and discomfort. As far as we can tell, expressivity cannot be reduced to the overall activity perceived in a motion sequence. In fact, when participants favour fast and ample movements as most representative of a high level of activity, they tend to choose slow and ample movements as the most expressive. Similarly, the effort conveyed by an action seems not to be a critical component of expressivity, as participants consider that a combination of medium speed and low amplitude is the most representative of an effortful action.



**Figure 2.** This figure represents, for each condition of speed and amplitude, the percentage of participants that chose this condition as the most representative of a given criterion (activity, discomfort, expressivity, effort, or regularity). We can see for instance that 45% of participants selected the low speed/high amplitude condition as the most expressive, whereas none of them considered it the most active.

Based on those results and informal observations from participants, we can tentatively assume that expressivity is primarily associated with properties we could call 'granularity' and 'readability', that is the possibility to observe details in the way a movement pattern unfolds and to identify specific moments inside this pattern. The low speed/high amplitude condition, the most expressive for a majority of participants, is often considered less mechanical and more charged with emotion, which may be related to the slow unfolding of a large undulation, giving time to observe the different ways the fabric stretches and ripples, and break down the different phases of the movement.

### 3 FUTURE WORK

This research inaugurates a series of studies on the minimal properties of expressive movement. On the notions of granularity and readability, it remains to be proved whether a movement

with more identifiable details and giving more possibilities to break down different temporal episodes is indeed considered more expressive than simpler movement patterns. Materials constituting the robot may also matter to its expressive potential. The expressivity of a movement may be related to the possibility to identify physical constraints governing the way a particular material deforms in specific situations. Further studies should include a systematic examination of the expressive potential associated to a movement pattern when realized with different structures and materials.

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