Designing and Evaluating the Face of Lil'Flo:
An Affordable Social Rehabilitation Robot

Michael J. Sobrepera[1−3], Enri Kina[1−3], and Michelle J. Johnson, Ph.D.[1,2,4,5]

[1]Rehabilitation Robotics Lab | [2]University of Pennsylvania | [3]Department of Mechanical Engineering
[4]Department of Physical Medicine and Rehabilitation | [5]Department of Bioengineering

Static and dynamic faces may not lead to differences in perceptions of machine-likeness, friendliness, and comfort. Different face designs show differences in perceived sentiment which can drive design decisions.

Need

- There is a shortage of rehabilitation workers in rural areas and developing countries which is expected to get worse. It will affect patients who require rehab, such as those with cerebral palsy, which afflicts 2-3 of every 1000 children born.
- Robots could help alleviate the shortage. Social robots can engage patients to motivate and encourage them through their rehab.
- A robot with a face may be able to convey emotion more effectively and build a stronger connection with humans than one without.
- There is a need to understand if making faces more dynamic is worth the additional cost.
- Understanding how patients respond to facial expressions is important for designing interactions.

Method

Determining the effect of a static versus dynamic face:

- Subjects were randomly assigned to a group presented with the face either static, in face G, or dynamic, cycling through faces B, C, D, G, H, and M.
- Subjects were asked questions about their feelings towards the robot.
- The mode was flipped half way through the interaction as the interview continued.
- More questions were asked, including ones which matched the first half of the interaction.
- The robot was covered and questions about the entire experience were asked.
- Responses were compared between participants in the two groups, looking only at the first mode in which they interacted with the robot, and within participants, comparing across the two modes.

Determining sentiment associated with different face patterns:

- The robot was then uncovered and cycled through all of the available faces, in random order.
- Subjects stated how they felt about each face and what they thought it represented.
- Responses were condensed and filtered to those with at least three responses.
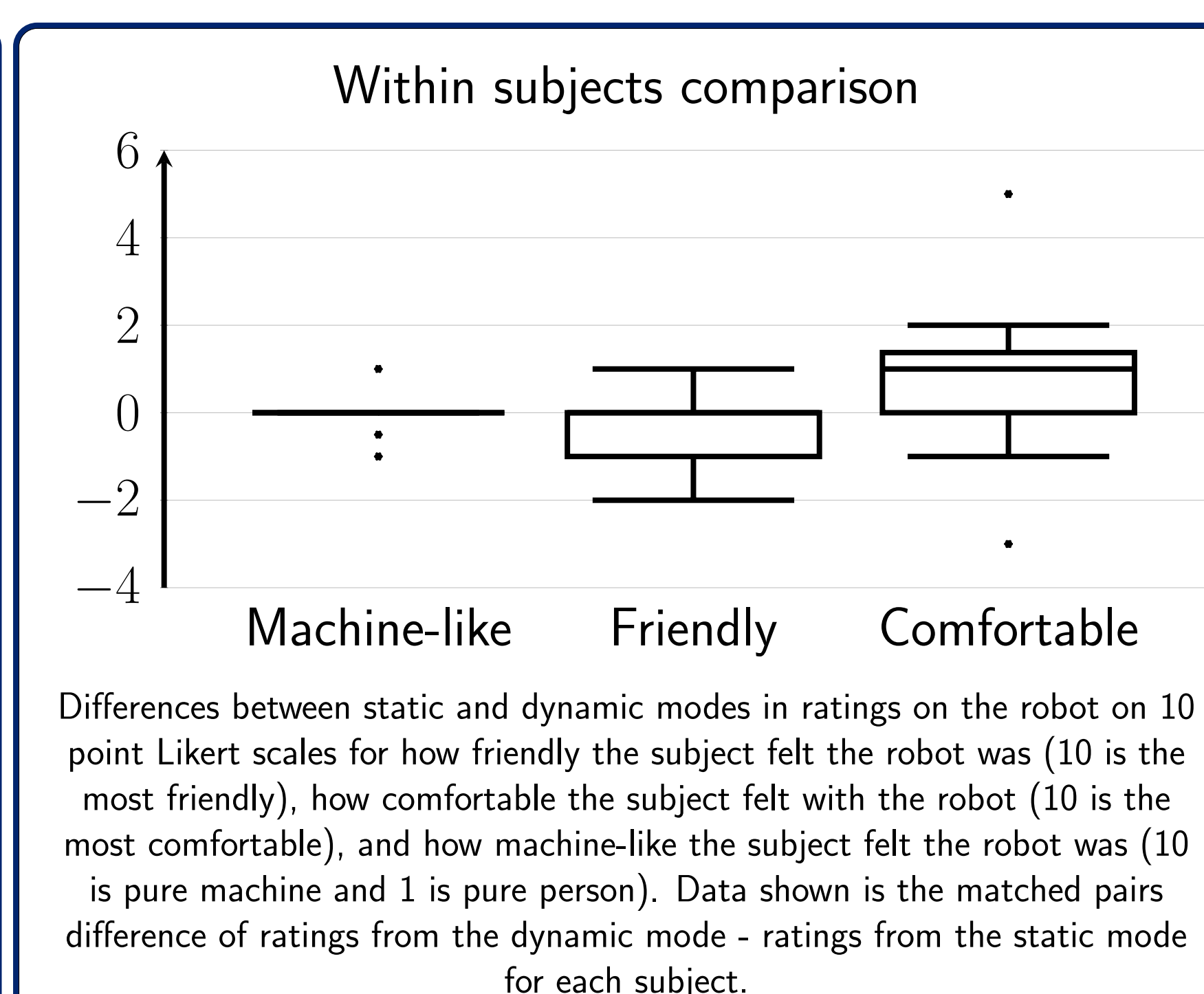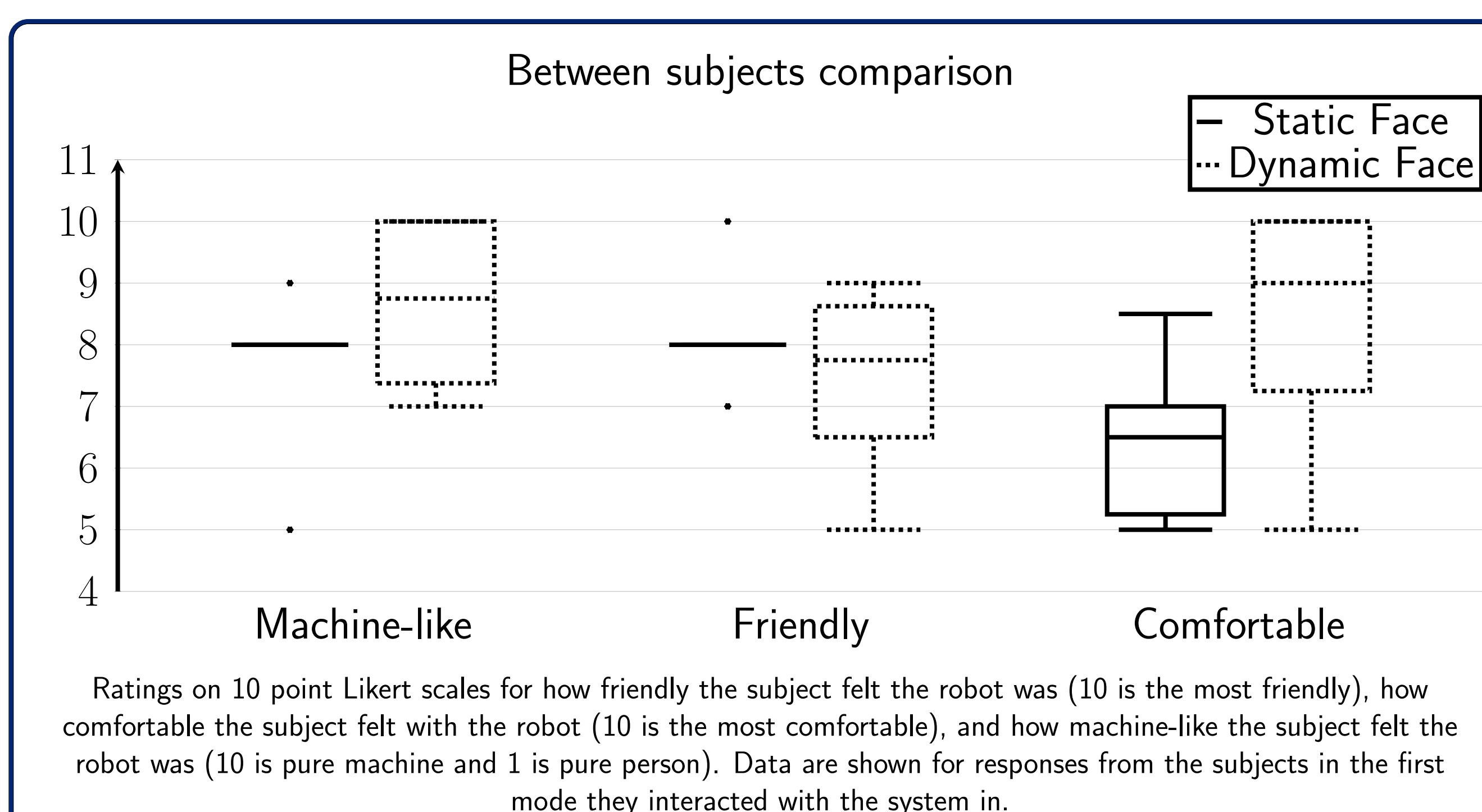
System

Sample

The sample consisted of 10 subjects, 6 females and 4 males, on average 20 years old. They had a self reported mean rating of 7.9 out of 10 on familiarity with computers and 4.9 on familiarity with robots.

Frequencies of perceived face sentiments reported by subjects

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
sad	0	0	0	0	0	4	0	0	0	0	8	4	0	6	0	0	0	9
happy	5	0	2	4	0	0	2	3	2	1	0	0	5	0	0	0	2	0
excited	0	0	4	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0
mischievous	0	5	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
neutral	2	1	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0
creepy	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	3	0
guilty	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	0	1	0
smug	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
laughing	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
scared	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	1
surprised	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
emoji	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
nervous	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0
confused	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0
upset	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0
very sad	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0

Comparing the static to dynamic mode

Between subjects comparison

Static Face / Dynamic Face

Ratings on 10 point Likert scales for how friendly the subject felt the robot was (10 is the most friendly), how comfortable the subject felt with the robot (10 is the most comfortable), and how machine-like the subject felt the robot was (10 is pure machine and 1 is pure person). Data are shown for responses from the subjects in the first mode they interacted with the system in.

Within subjects comparison

Differences between static and dynamic modes in ratings on the robot on 10 point Likert scales for how friendly the subject felt the robot was (10 is the most friendly), how comfortable the subject felt with the robot (10 is the most comfortable), and how machine-like the subject felt the robot was (10 is pure machine and 1 is pure person). Data shown is the matched pairs difference of ratings from the dynamic mode - ratings from the static mode for each subject.

Analysis

Testing the effect of a dynamic versus static face showed no significant difference across the metrics of friendliness, comfort, and machine-likeness.

The exploration of the face designs shows some faces which have a clear sentiment associated with them and others which do not, allowing us to select appropriate faces for our system. Some faces showed unexpected sentiments, such as G, which is less happy and more creepy than expected. The sentiments surprised, nervous, and confused, all of which could be useful in rehabilitation interactions, are not shown as being well expressed in the current face set.

Penn Engineering | GRASP Laboratory
General Robotics, Automation, Sensing & Perception Lab

Rehabilitation Robotics Laboratory

Perelman School of Medicine
UNIVERSITY of PENNSYLVANIA