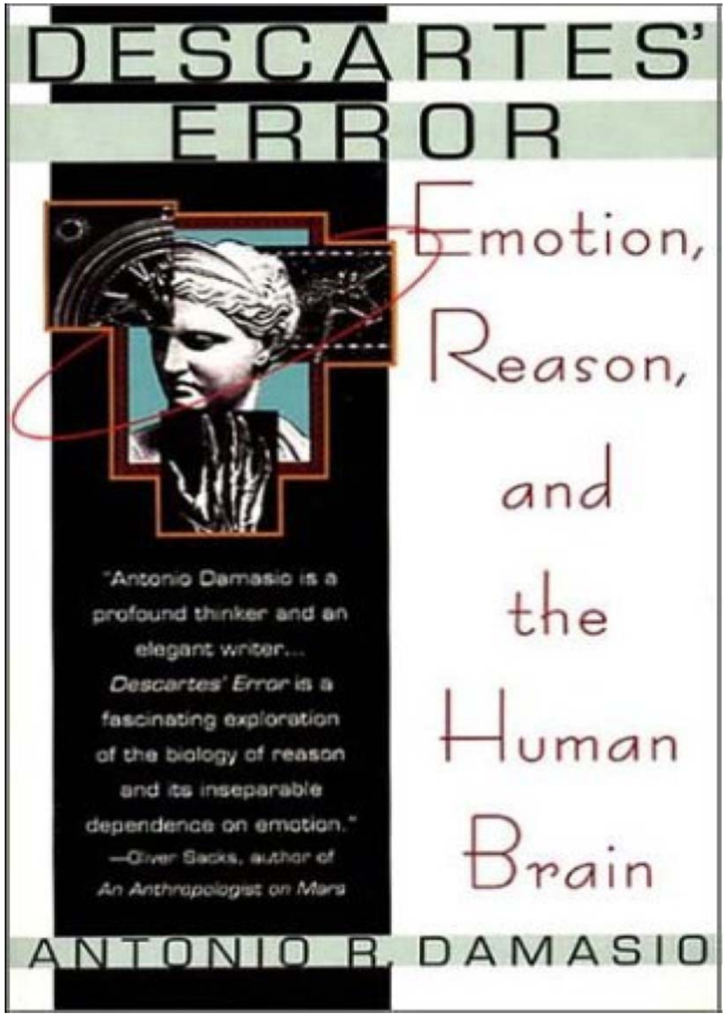
Affective-aware technology for Ubi-Health: the case of chronic pain rehabilitation

Nadia Bianchi-Berthouze
UCLIC, University College London

EMOTION AND COGNITION| Interacting processes

- Cognition and Emotion as interacting processes
  - Emotions can bias behaviour, perceptions, preference
  - Emotions support decision process
  - Emotions support effective and adaptive behaviour
- Emotion is embodied (touch, movement, etc.)



AFFECTIVE COMPUTING| Aims

- Designing technology that is aware of their user affective experience and can support, regulate or amplify it.

  – Positive experience, positive self-image, enhance motivations, social interaction, support cognition

  – Applications: games, education, rehabilitation, fitness, well-being, product design, …..

Do emotions matter in physical rehabilitation?

EXERGAMES| Not just for fun … but for health

RehabMaster, Hanyang University
(RISE - Research Institute of Serious Entertainment)

Are monitoring, fun, positive rewards sufficient?

PHYSICAL REHABILITATION IN CHRONIC PAIN

Emo&Pain

WWW.EMO-PAIN.AC.UK

NHNN

CHRONIC PAIN | what is it?

- Chronic pain
  - Persist for more than 3 months passed the healing phase
  - 1 on 7 people has chronic pain
  - Changes in the central and peripheral nervous system resulting in amplification of pain signals

- Chronic pain is a disabling condition
  - work, daily activities, relationships, mental health, general health.

CHRONIC PAIN | Physical Rehabilitation

- Rehabilitation aims
  - Self-manage one's condition
  - Maintain/regain functions rather than cure
- Physical activity
  - protects against weakening and stiffness
  - inhibits neurophysiological mechanisms underlying the spread of pain;
  - increases confidence in physical capacity → achieving valued goals (Gatchel'07)
- Emotions as a barrier to physical activity (Crombez '12)
  - Wrong beliefs about meaning of pain
  - Fear of injury, fear of increased pain
  - Negative emotions increase sensitivity to pain
  - Fear-avoidance model: negative emotions facilitate acute to chronic transition

CHRONIC PAIN | A communicative language

- People with chronic pain exhibit communicative and protective behaviour (Sullivan et al., 2006)
  - Facial expressions such as grimacing communicate with or without intention the presence of pain
  - Body behaviour: protect one's body from injury or pain increase but has also to communicate their state and fear to other (e.g., fear of injury).

- Pain-related behaviours in chronic pain is at best weakly correlated with the intensity of pain or seriousness of the condition (Teske et al., 1983)

BODY BEHAVIOUR | Lack of awareness

- People are not necessarily aware of their non-verbal behaviour.
  - Automaticity
  - Dysfunction of the proprioception system
  - Avoid looking at video or mirror

- Many patients showed surprise on seeing their body movement replayed by an avatar.
  - meticulously observing of their avatar
  - noticing protective behaviour and keen to understand it.

BODY BEHAVIOUR | Social effects

- Protective behaviour used to evaluate personality traits (Martel et al, 2012; Ashton-James et al., submission)

- People showing pain-related behaviour are considered
  - less ready to work, less competent
  - less likable
  - less dependable
  - Less warm

  than people not exhibiting any pain-related behaviour.

- Protective behaviour less likable and dependable than communicative behaviour

PHYSICAL REHABILITATION | Programme

- Cognitive behavioural approach
  - To understand pain
  - To learn to manage their condition
  - To learn to assess their own capability
- Some countries offer pain management programs
  - Good results ….. But return to initial stage after leaving the programme

CAN TECHNOLOGY HELP| HOW?

- Qualitative studies to better understand needs, barriers, strategies
  - Interviews with 14 CP patients
  - 7 Blogs and 18 Forums for Chronic Pain (25 CP patients)
  - Pain management class observation followed by video-cued interviews
    - 3 physiotherapist-led groups or gym exercise sessions with 12 patients);
    - 2 pain management introduction sessions with 15 patients

Singh, et al. Motivating People with Chronic Pain to do Physical Activity: Opportunities for Technology Design, CHI'14

INTERVIEWS| Results Summary

- A journey
  - Support tailored to people and phase
- Progress
  - Not a continuous path, Set backs
  - Emotional barriers (e.g., depressions, frustration, fear)
  - Evaluation: not just physical but psychological
- Physiotherapist's role → Technology's role
  - Facilitate transfer, teaching skills, focus on pleasurable sensation, promoting self-esteem, enhancing awareness
- Strategies
  - Going with the flow vs. being correct
  - Active but not over-active
  - Bad days keep going
  - Rewards, feeling good

INTERVIEWS| The journey of pain management

- Managing expectations of change and focusing on improving function in daily life despite pain rather than finding a cure.
  - *"I think it's about where people are in their journey, … some people may decide they are in a recovery journey, some people may still be in a pain jungle where they are looking at how do I get out of this place, and some people may be quite far away from that jungle …"* (Patient).

INTERVIEWS| The journey of pain management

- Explore capability (set baselines)
  - Discover what ones' can do
  - Build **confidence** in movement

- Build on current capability (on baselines)
  - Importance of building activity **slowly and steadily → no overdoing**

  "***It is quite interesting initially how little you can do but that if you just do that very very little, how quickly it builds, but if you think, well, I did one today I'll do six tomorrow, you're going to go backwards*" (OFP2).**

  - COMPETITION?

- Maintain increase of capability
  - Even in **low-mood days**
  - But **readjustment in case of temporary setback**

UCLIC

INTERVIEWS| Progress

- Not a continuous steady progress but full of trial and error, and can feel risky because of negative past experiences.
  - *"If I were to deliberately go for a walk and just did more everything, I would say due to past experience... my mobility would be practically zero for at least 3 or 4 days after*." (P2).

- Starting an activity programme produce pain in underused muscles and joints, which can increase anxiety about damage. Needs for re-assurance
  - *"healthcare professionals need to tell patients that when you start exercise your pain may increase but it will drop away*." (P10).

INTERVIEWS| How to evaluate progress

- Progress is not just about physical capabilities but psychological ones
  - What is their understanding of pain? how confident they are? what is their perception of their own capability?

***"just building up the muscles to do an activity does not translate into confidence in doing the actual tasks that people want to do."* (PT3)**

"people come to see us they may have seen 5 or 10 or more physios and they've got reams and reams of exercises but they're not adding up to the functional change that they want to see." (PT2)

INTERVIEWS| Strategies
Going with the flow vs. correcting movement

- CP people emphasised that they would like to be corrected when the activity was perceived to be "wrong" because it risked damage.
  - *"it's very beneficial to have somebody correcting you because your body always wants to do it the easiest way and what you've actually got to do is to get your body to do it the correct way."* (PT1)

- BUT physiotherapists
  - concerned that correcting movement increased anxiety about damage
  - put much less emphasis on a "correct" way of moving and more on regaining confidence in movement

INTERVIEWS| Physiotherapist role: pleasurable sensation

- Focused on neutral or pleasant sensations rather than on the exercise.
  - *“We want to try and encourage people to hold the stretch for at least 10 to 15 seconds, up to 30 seconds, but trying to tie together working out ‘<u>how many breaths do I take during that time’</u> and using that to count can work for making sure they are breathing through the exercise, but also putting a bit more of the responsibility on them to choose: ‘OK I've done enough of this now. I've done my ten seconds.’ Then that habit might be a bit easier when they're on their own.”* (OP2).

INTERVIEWS| Exercise adherence – motivations

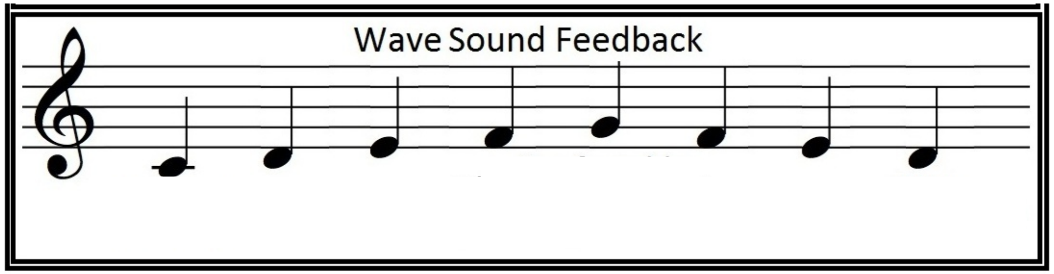
- ***Feel good factor***: immediate benefit or a sense of achievement.
  - getting through exercises or a physical exercise routine was a reward in itself because they felt better afterwards:
    - "*Kind of I'm tired in that nice way after the exercise*" (P3).

- ***Reward strategies***: set themselves incentives for physical activity because it strengthened motivation.
  - Physiotherapists encouraged people to reflect on what motivated them to increase activity.
    - *"...we encourage people to think about what would work for them so we'll mention setting short term goals, acknowledging achievement, giving yourself reward; but we'll just talk about general examples and say to people you know what would work for you."* (PT2).

TECHNOLOGY (1)| Body movement awareness

TECHNOLOGY (1)| Body movement feedback

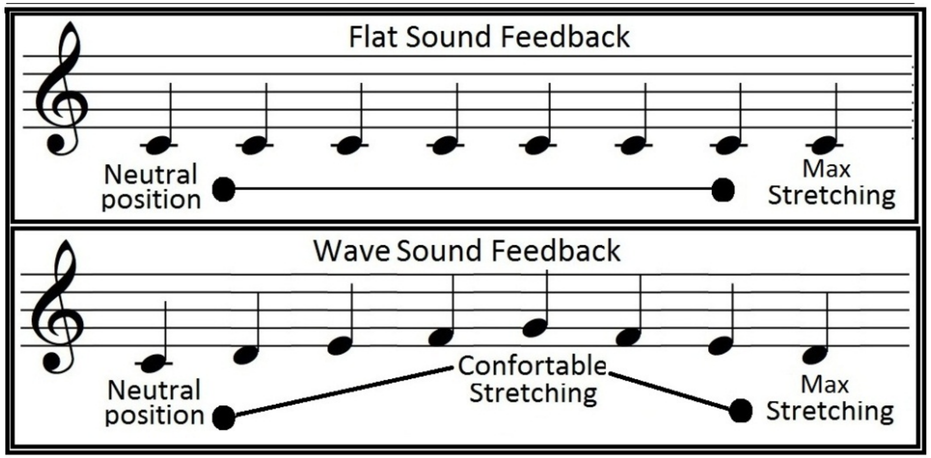
- Aims:
  - Increase awareness of movement focussing on pleasurable rather the feared aspects of movement
  - Increase confidence and self-efficacy
  - Compensate for altered proprioception
  - Facilitate transfer of control & exploration of one's capabilities
- Sound feedback:
  - Facilitate introspection, reduce anxiety (?)
  - Facilitate movement



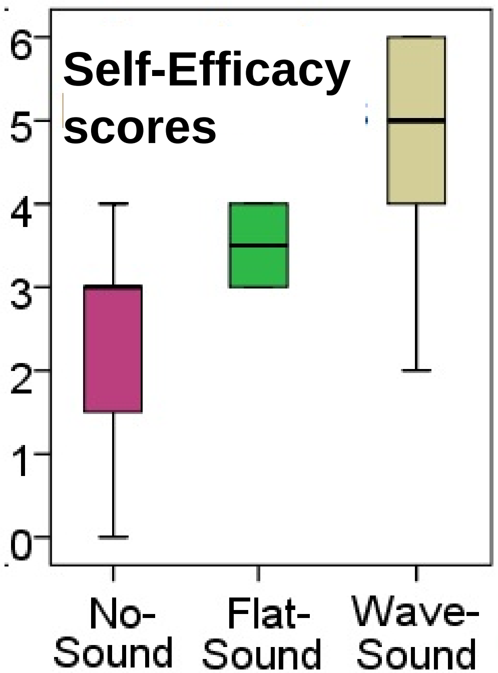
UCLIC

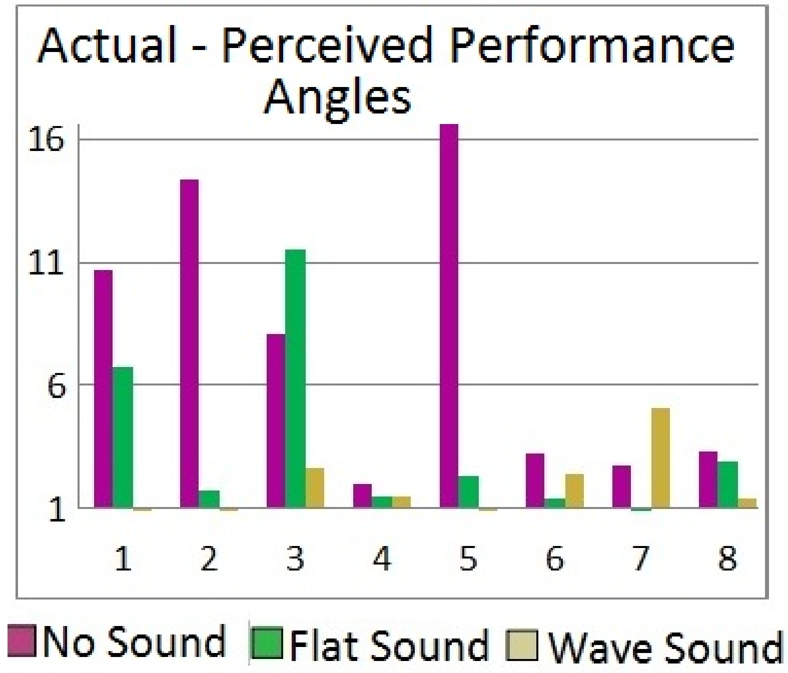
TECHNOLOGY (1)| Body movement feedback

- Self-directed calibration



TECHNOLOGY (1)| Preliminary results





- Perceived performance: $\chi^2(2) = 4.571$, $p = 0.01$, Post-Hoc tests: no-sound vs flat (W= -15, p = .027) and wave (W = -31.00, p = .016)
- Differences between perceived and actual angle smaller for sound than for no-sound : $F(2, 21) = 4.177$, $p = .038$, $\mu^2=.374$). More accurate perception during flat sound ($t = -2.39$, $p = .024$) than no sound

TECHNOLOGY (1)| Preliminary results

- All participants found auditory feedback useful and motivating
  - Information about their progress
  - Efforts and sense of space and time

- All but one participant preferred the wave feedback to the flat as more informative:
  - *"to focus on something other than what you are doing. With the up and down sound, I can hear more clearly how I am doing."* (PCP3).
  - *"I can tell if I am approaching my max stretch.* (PCP7);
  - *"Hearing the sound pitch help me be more engaged and makes it easier for me"* (PCP6).

TECHNOLOGY (1)| Preliminary results

- Sound feedback used to set challenges, and visualise effort

  – *"With the shape sound, it seems like I was climbing a mountain while the pitch increased. After passing the top position, I would know that I have passed a certain level and it just encouraged me that I might be able to do a bit more than that. Just very clear about where I was. But without the sound, you have no idea"*. (PCP2).

  – *"The up and down one, it gives me something to achieve and I know how close or how far I am to the goal"* (PCP6).

UCLIC

TECHNOLOGY (1)| Preliminary results

- The wave sound feedback added fun and pleasure.
  - *"The [wave] sound is more exciting, welcoming, inspiring. The shape makes me laugh, happier*." (PCP5).
  - *"The wave sound] gives a feedback of how well I was doing. I can see myself playing games with it*."

- Sound complexity:
  - One person preferred the flat version to the wave version as she felt the second one was too distracting (PCP1).
  - The complexity of the wave feedback may be why the flat sound led to better accuracy in perception of bending (PCP1).

TECHNOLOGY (1)| What's next?

- How complex the sound? → boring
  - – Sound or music?
  - – What sound/music? Whose' taste?
- What should be mapped?
  - – Movement, breathing, muscle activity .....
- How many signals at the same time?
- Run-time music authoring?
  - – Decomposing/recomposing music – what skills?

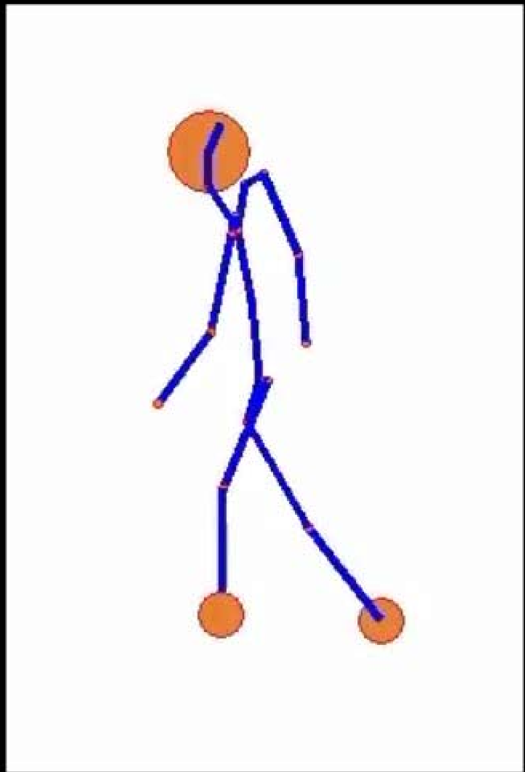
TECHNOLOGY (1)| What's next?

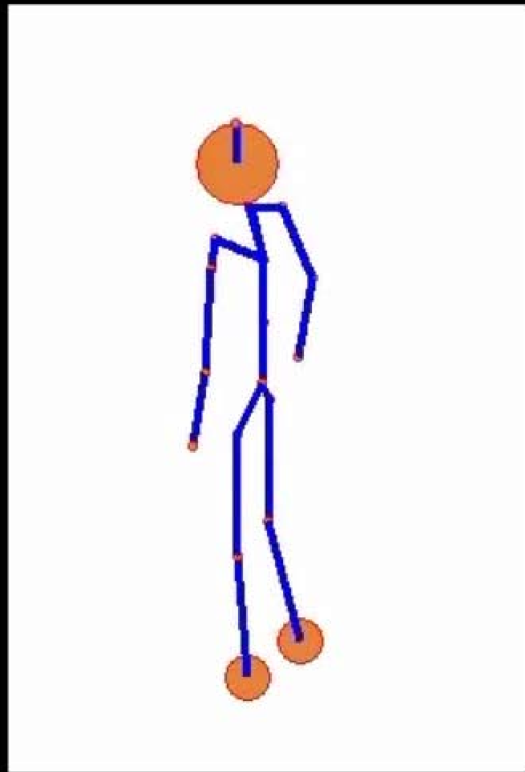
- How to support building capabilities?
- How to support reward?

TECHNOLOGY (2)| Emotion-aware technology

Need to tailor support to emotional states among other factors

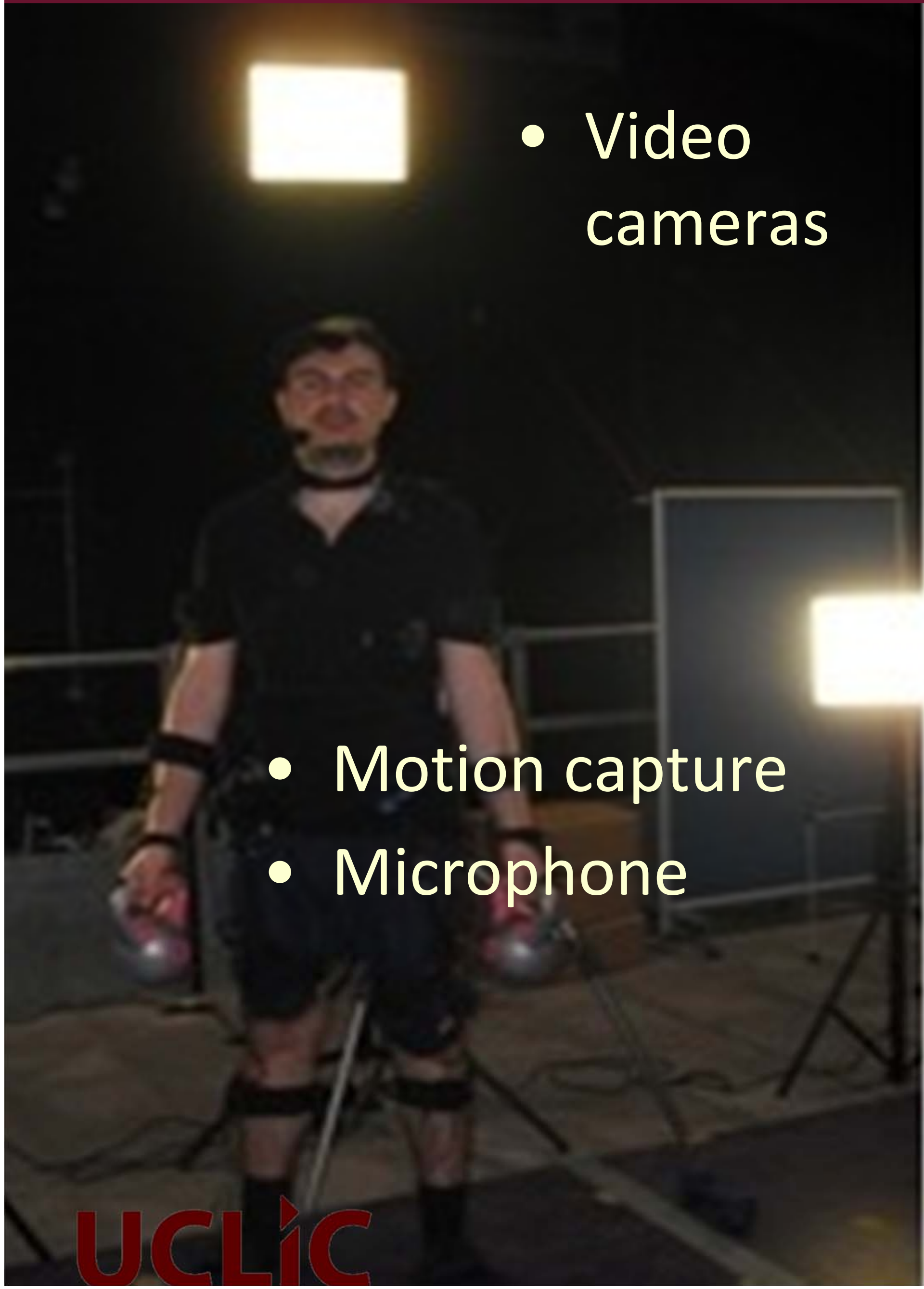
TECHNOLOGY (2)| Emotion-aware technology

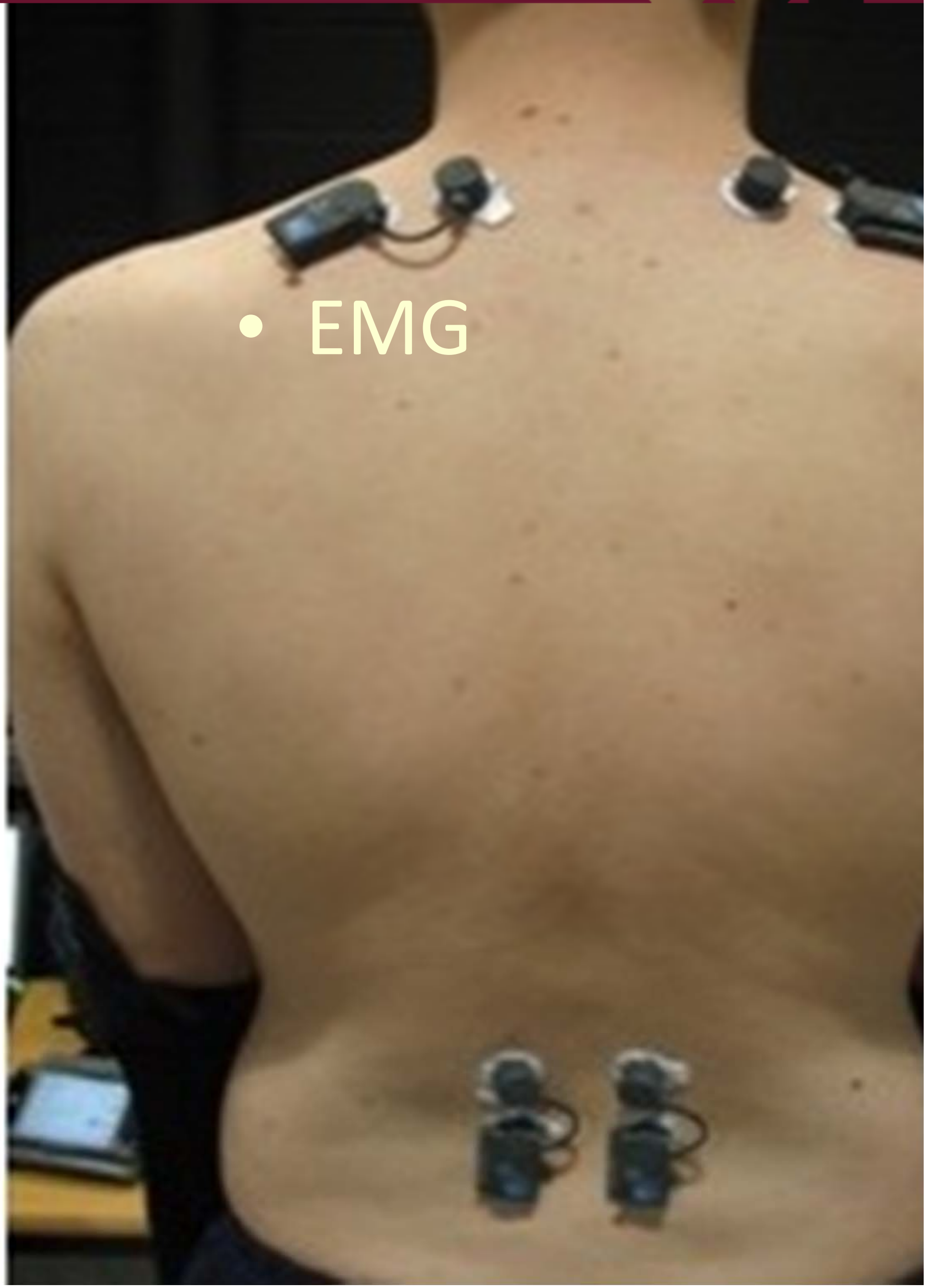




N. Kleinsmith A, Bianchi-Berthouze N. "Affective Body Expression Perception and Recognition: A Survey", *IEEE Trans. on Affective Computing*, 4(1): 15-33, 2012.

Sensors

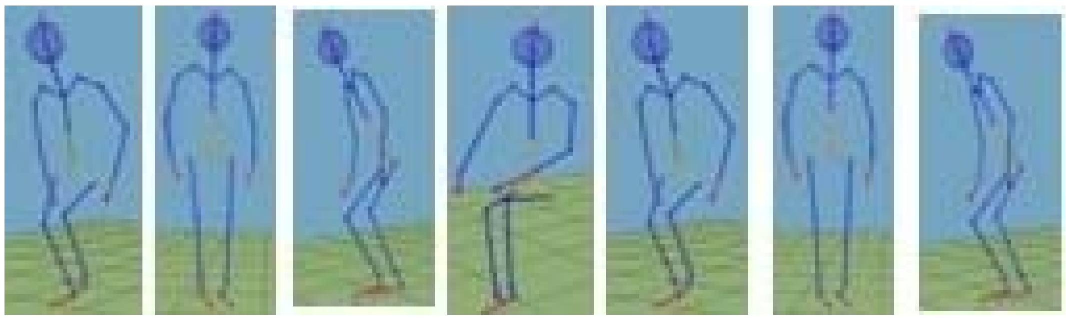




- Video cameras
- Motion capture
- Microphone
- EMG

TECHNOLOGY (2)| Data collection

- 21 participants with chronic low back pain
- Between 1-3 trials: range of physical exercises
- Each session lasted about 15 min.
- 4 experts rated the recorded videos to identify protective behavior video segments.



UCLIC

TECHNOLOGY (2)| Data collection

- 105 instances of sit-to-stand exercise
  - 40 labeled as *Guarded*
  - 65 labeled as *Not Guarded*.
- 152 instances of standing on one leg
  - 83 labeled as *Guarded*
  - 69 labeled as *Not Guarded*.

Aung, et al. , N. (2013). Getting rid of pain-related behaviour to improve social and self perception: a technology-based perspective. *IEEE WIAMIS'13*

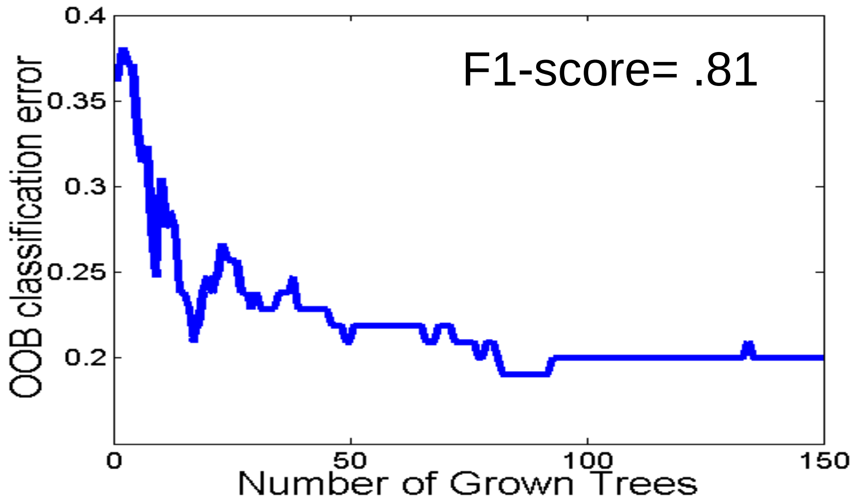
TECHNOLOGY (2)| Modeling

- Kinematic Features computed over each exercise data segment.
  - ranges of joint angles, means of joint energies, jerkiness of trajectory, means of rectified EMG values.

- Automatic Recognition:
  - Random Forest algorithm: ensemble of 100 trees trained using a subset of all available features
  - Each tree is created using an in-bag sample 2/3 of the original data.

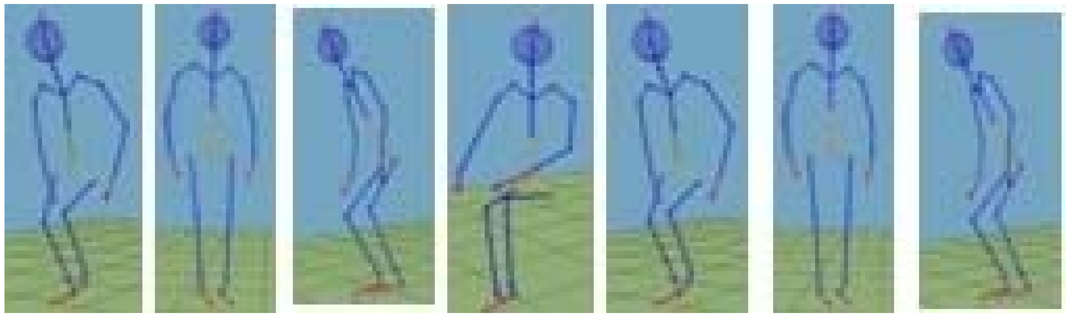
TECHNOLOGY (2)| Results for stand-to-sit

		Physiotherapists	
Predicted		Not Guarding	Guarding
	Not Guarding	46	12
	Guarding	9	38
	Total	65	40



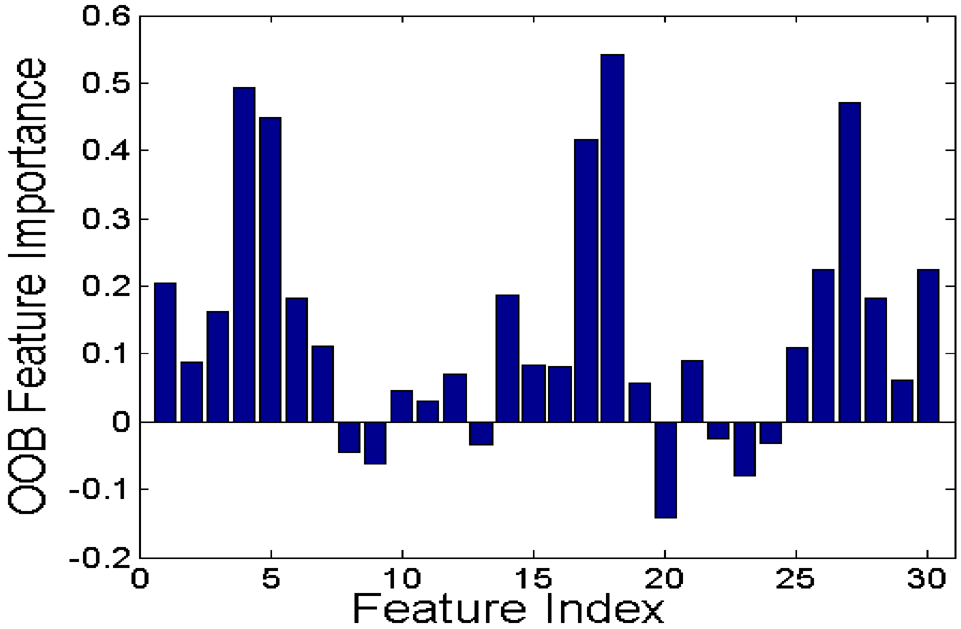
UCLIC

TECHNOLOGY (2)| Results for stand-to-sit



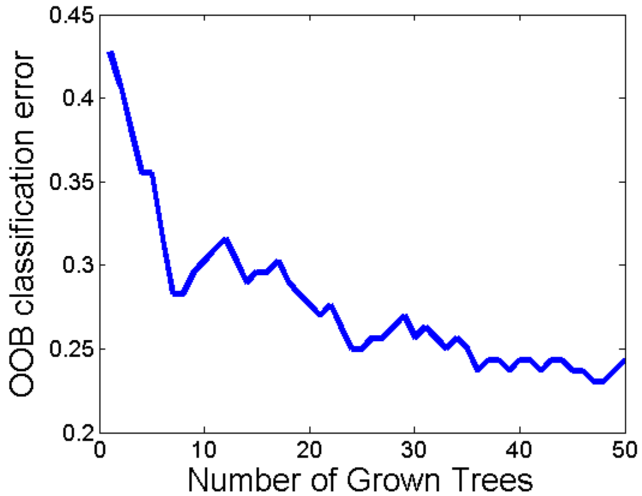
Features

1-13: body-joint angle ranges
14-26: body-joint energy
27-30: mean of rectified EMG.



TECHNOLOGY (2)| Results for balance-on-one-leg

		Physiotherapists	
		Not Guarding	Guarding
Predicted	Not Guarding	45	11
	Guarding	24	72
	Total	69	83



F1 = 0.72
precision = 0.65
recall = 0.8

TECHNOLOGY (2)| Exploiting idiosyncrany

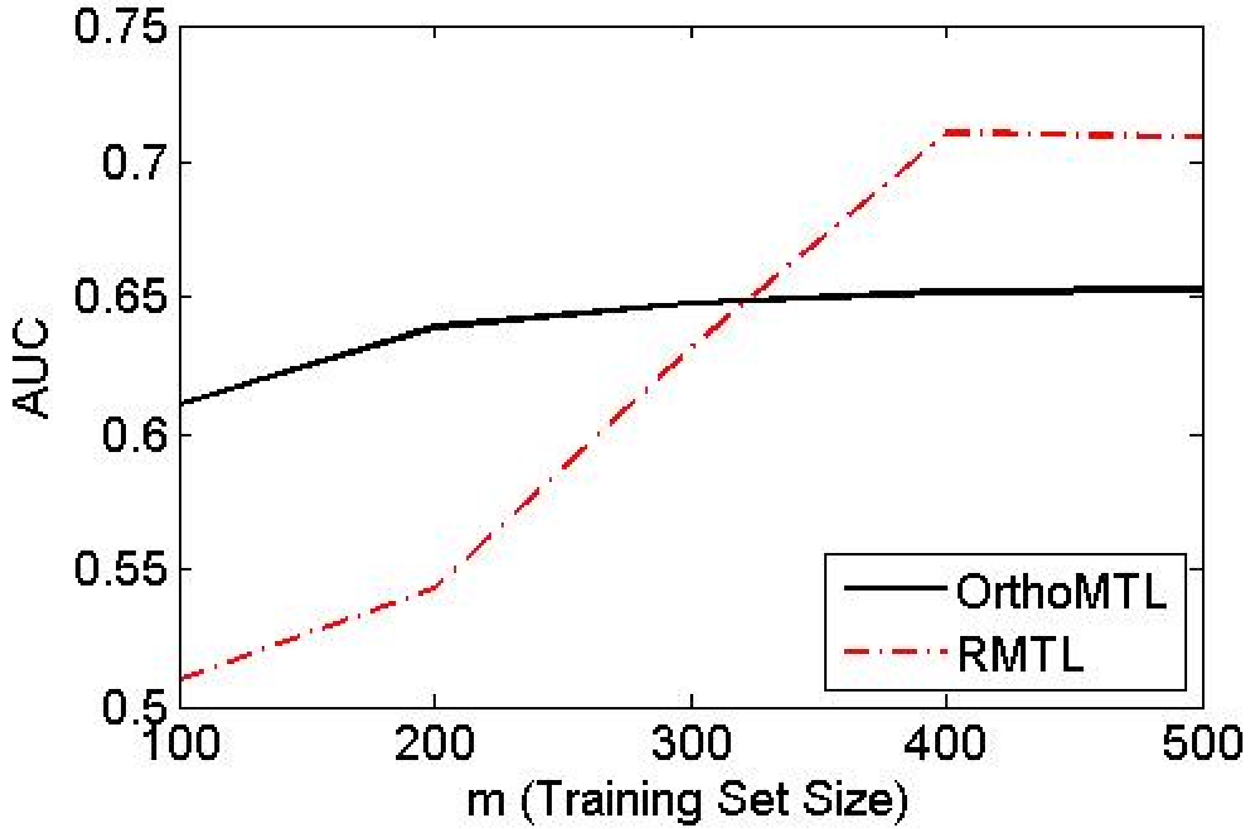
Biases caused by idiosyncratic behaviours has significant effect on affect recognition performances

OrthoMTL	Transfer Learning

• Aim: Perform inference on new subjects when no information is provided
• Assumptions: the features which are influential for affective recognition
  • confound identity recognition
  • are orthogonal to the ones for identity
	• A few instances of the target subjects are available
	• Assumptions:
	  • commonalities exist within a group of subjects expressing the same emotion
	  • idiosyncrasies affect the instantiation of such communalities

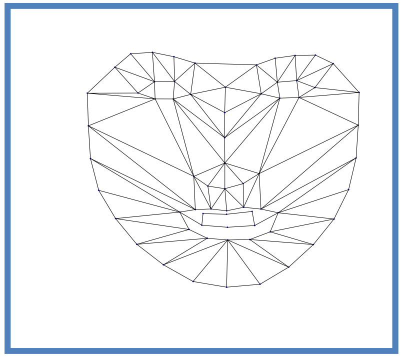
Romera-Paredes, B., Min, H. A., Bianchi-Berthouze, N., Pontil, M. Multilinear Multitask learning. *ICML'13*

TECHNOLOGY (2)| Results for guarding behaviour all exercises (frame by frame)

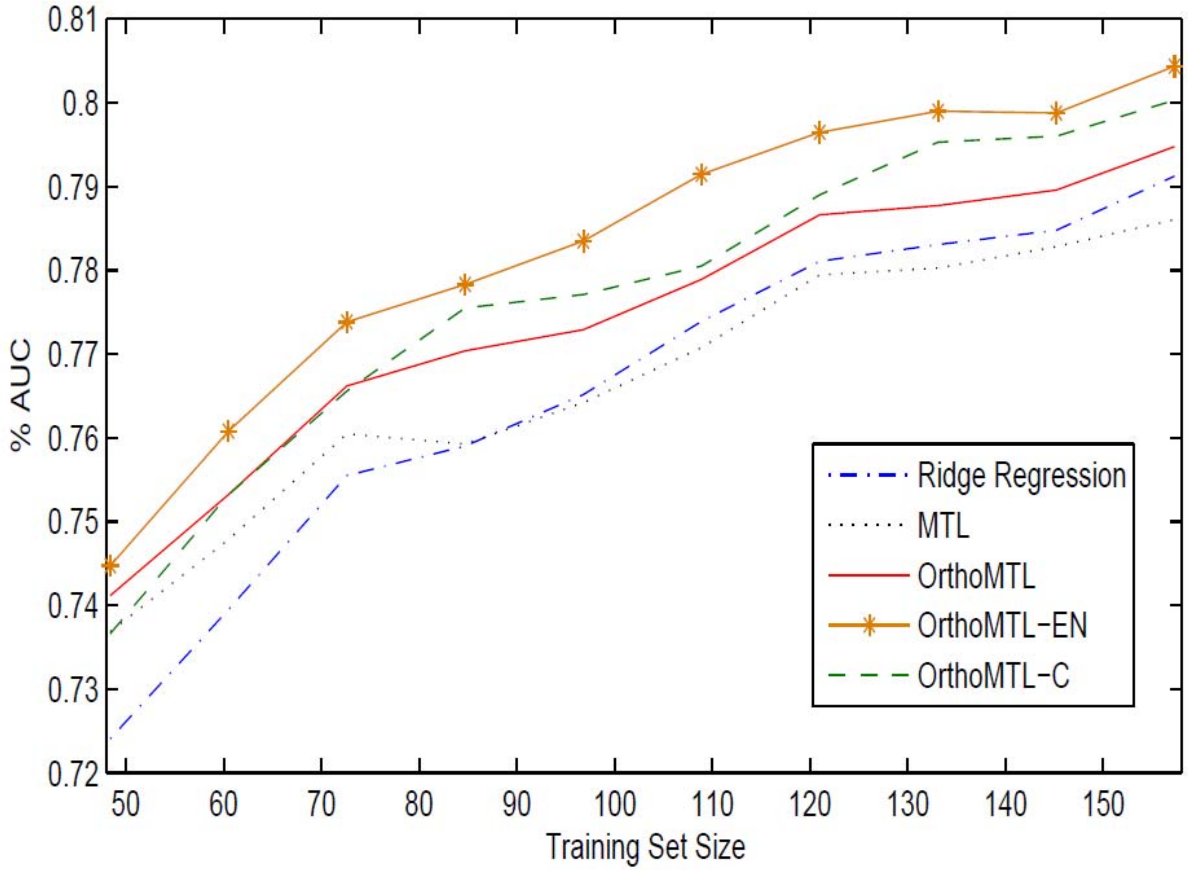


Romera-Paredes, B., Aung, M. S. H., Pontil, M., Williams, A. C. D. C., Watson, P., Bianchi-Berthouze, N. (2013). Transfer learning to account for idiosyncrasy in face and body expressions. *10th International Conference on Automatic Face and Gesture Recognition, 2013. FG 2013*

TECHNOLOGY (2)| Results facial expressions

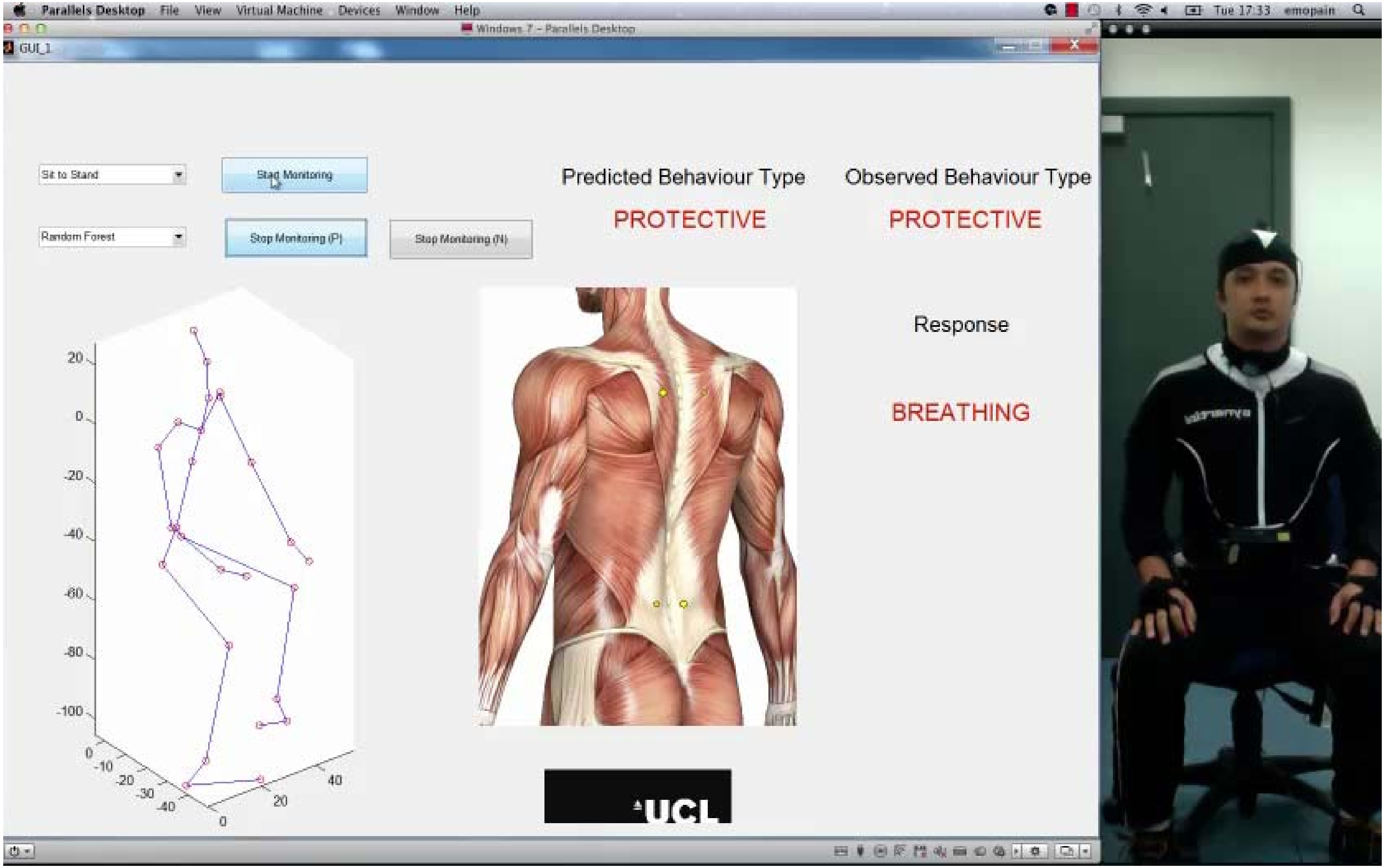


UNBC-McMaster
Shoulder Pain
Expression Archive
(Lucey, 2011)



UCLIC

TECHNOLOGY (2)| On-line detection



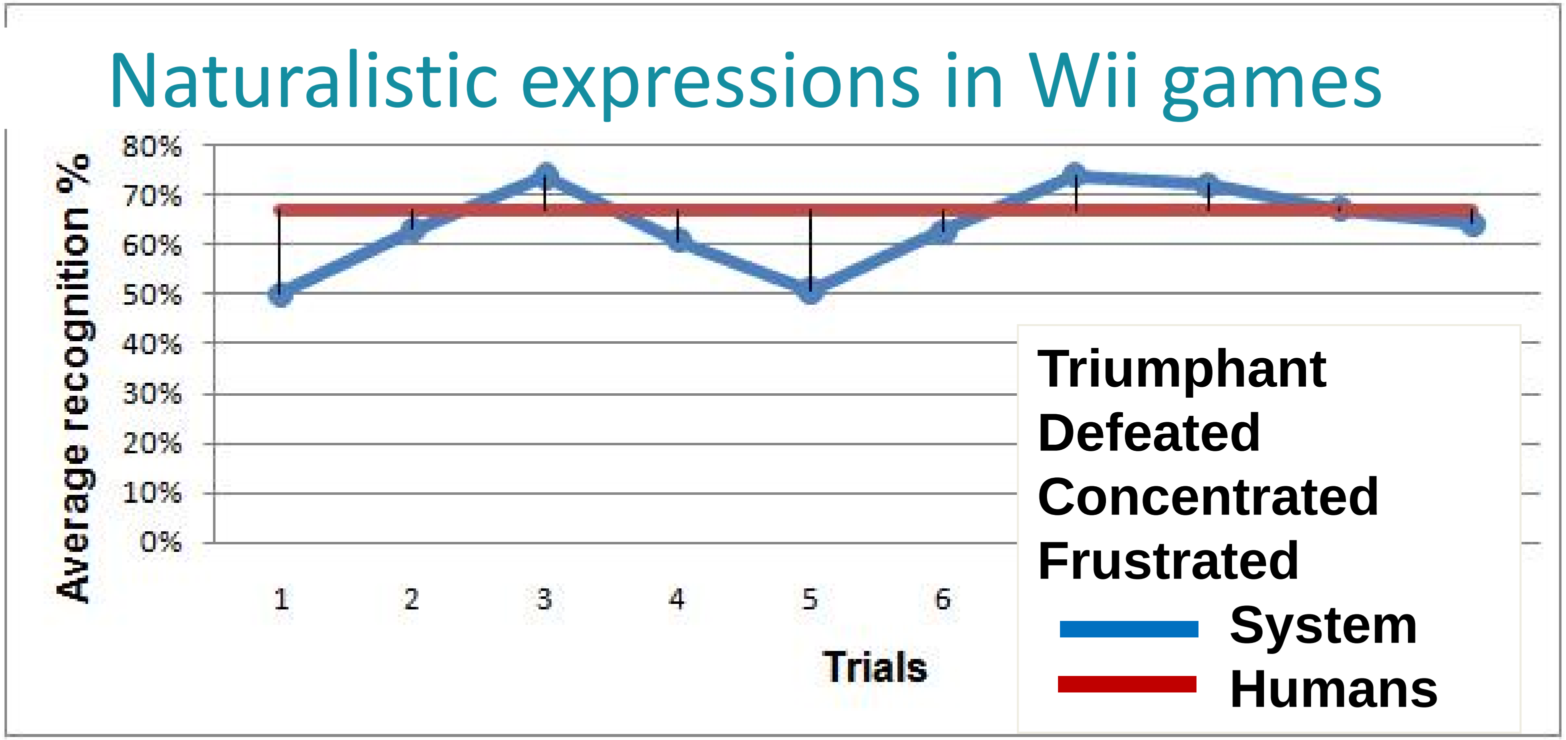
AffectME: Recognizing and regulating emotions in full-body game technology (MIRG FP7)

Body expressions in game play

(AffectME: naturalistic dataset)

UCLIC

GAME PLAY| Automatic classification



- Savva, N., Scarinzi, A., Bianchi-Berthouze, N. (2012). Continuous Recognition of Player's Affective Body Expression as Dynamic Quality of Aesthetic Experience. *IEEE Transactions on Computational Intelligence and AI in Games* 4(3), 199-212
- Kleinsmith, A., Bianchi-Berthouze, N., Steed, A. (2011). Automatic Recognition of Non-Acted Affective Postures. *IEEE Transactions on SMC, Part B* 41(4), 1027-1038

ILHAIRE: Laughter-aware conversational agents
(EU-FP7 2011-2014)

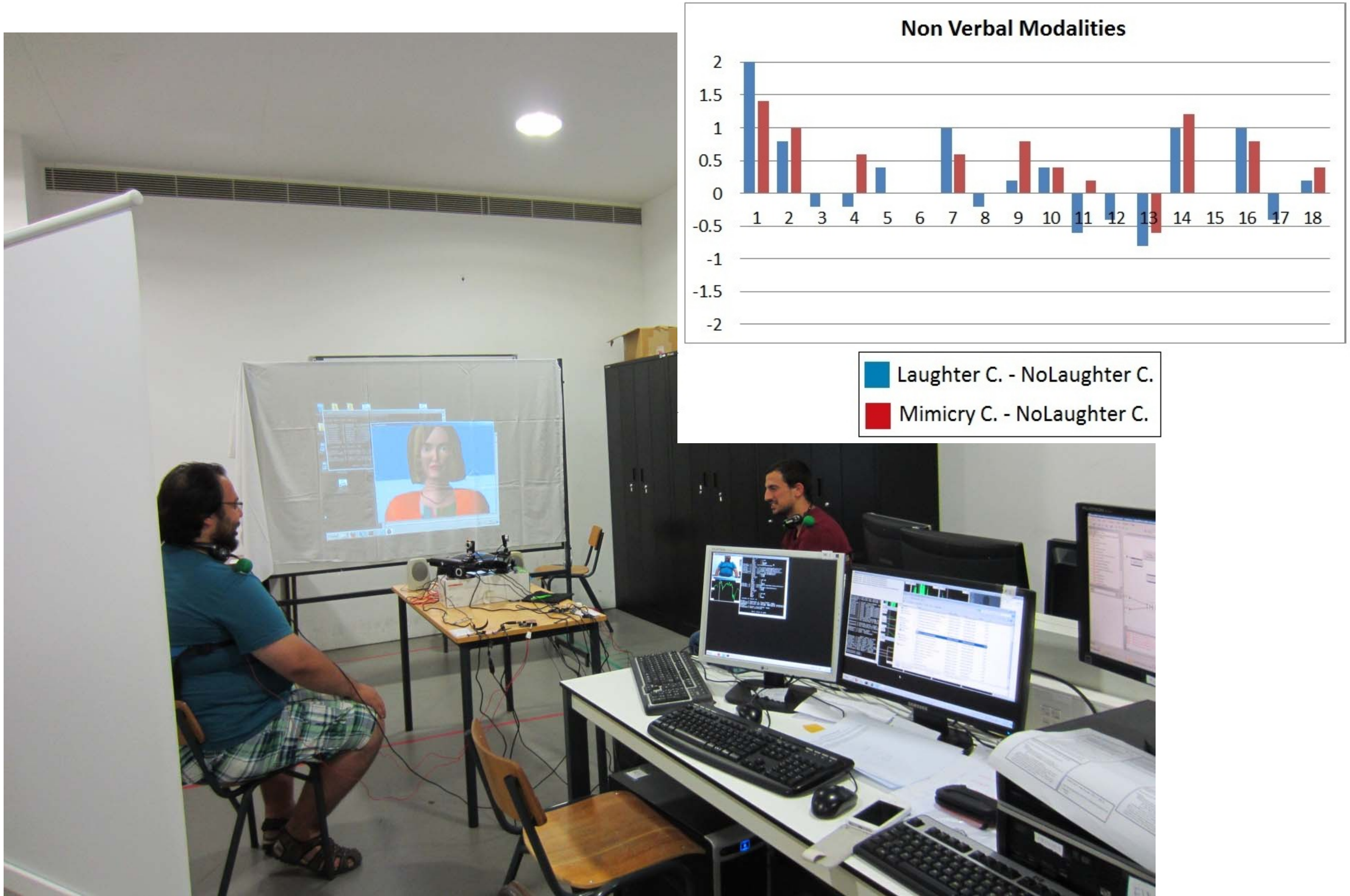
Detecting laughter types in body cues

http://www.ilhaire.eu/

UCLIC

UCL

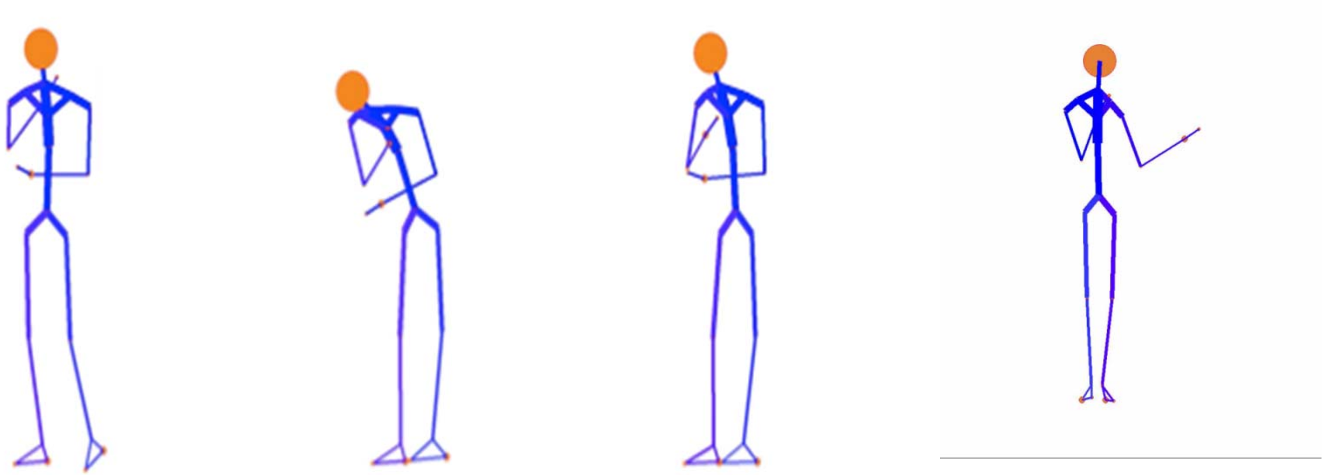
LAUGHTER| Interacting with a laughter-capable avatar



UCLIC

LAUGHTER| Data collection

(UCL Dataset available at www.ilhaire. eu)



Hilarious
Social
Awkward
Fake
No laughter

9 pairs of participants
126 clips selected

UCLIC

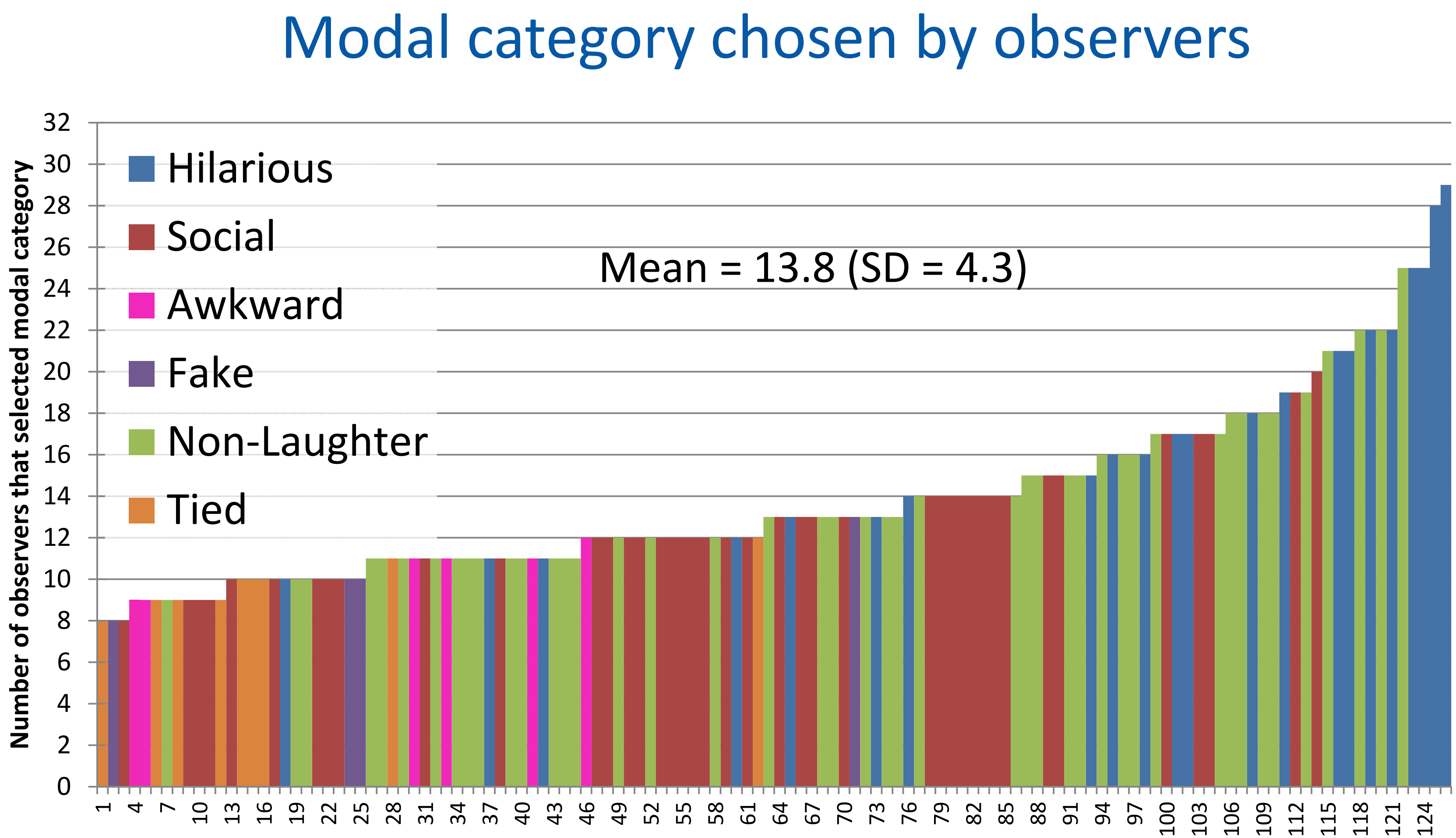
LAUGHTER| Perceptual Study

- 32 observers (17 male, 15 female, mean age 33.0)
- Laughter categorisation:
  - Hilarious
  - Social
- Awkward
  - Fake
  - Non-laughter
- Definitions and examples given

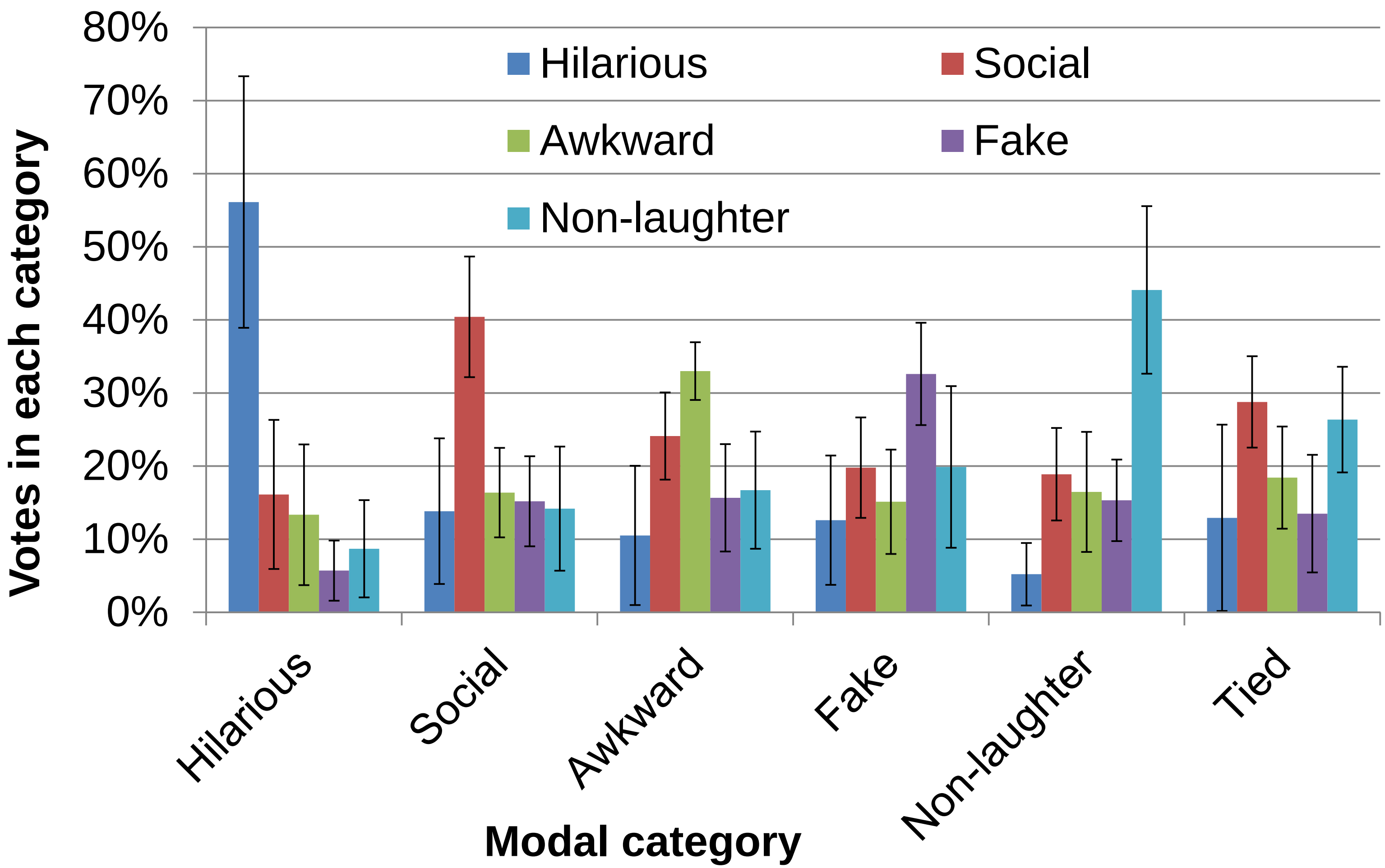
  "Social: This may be polite laughter as part of a conversation. It can show an acknowledgement of what another person has said is correct or show courtesy and good manners to the speaker.

  Example: Someone is having a conversation with a friend and is laughing as a way of acknowledging what their friend is saying and showing that they are enjoying their friend's story/anecdote."

LAUGHTER| Label distribution



LAUGHTER| Modal category and Label distribution



Griffin, H. J., et al. (2013). Laughter Type Recognition from Whole Body Motion. ***IEEE ACII'13***

Body Part	Features returning max, min, range
Hands distances	Distance between hands
	Distance between hands and head
	Distance between hands and hip
Trunk bending	Angle at lower spine joint
	Angle at upper spine joint
	Angle at neck joint
	Sum of all spine angles
Trunk bending direction	Anterior-posterior component of lower spine→upper-spine segment direction
	Anterior-posterior component of upper-spine→neck segment direction
	Anterior-posterior component of neck→head segment direction
	Lateral component of lower spine→upper-spine segment direction
	Lateral component of upper-spine→neck segment direction
	Lateral component of neck→head segment direction
	Rotation of shoulders relative to hip line

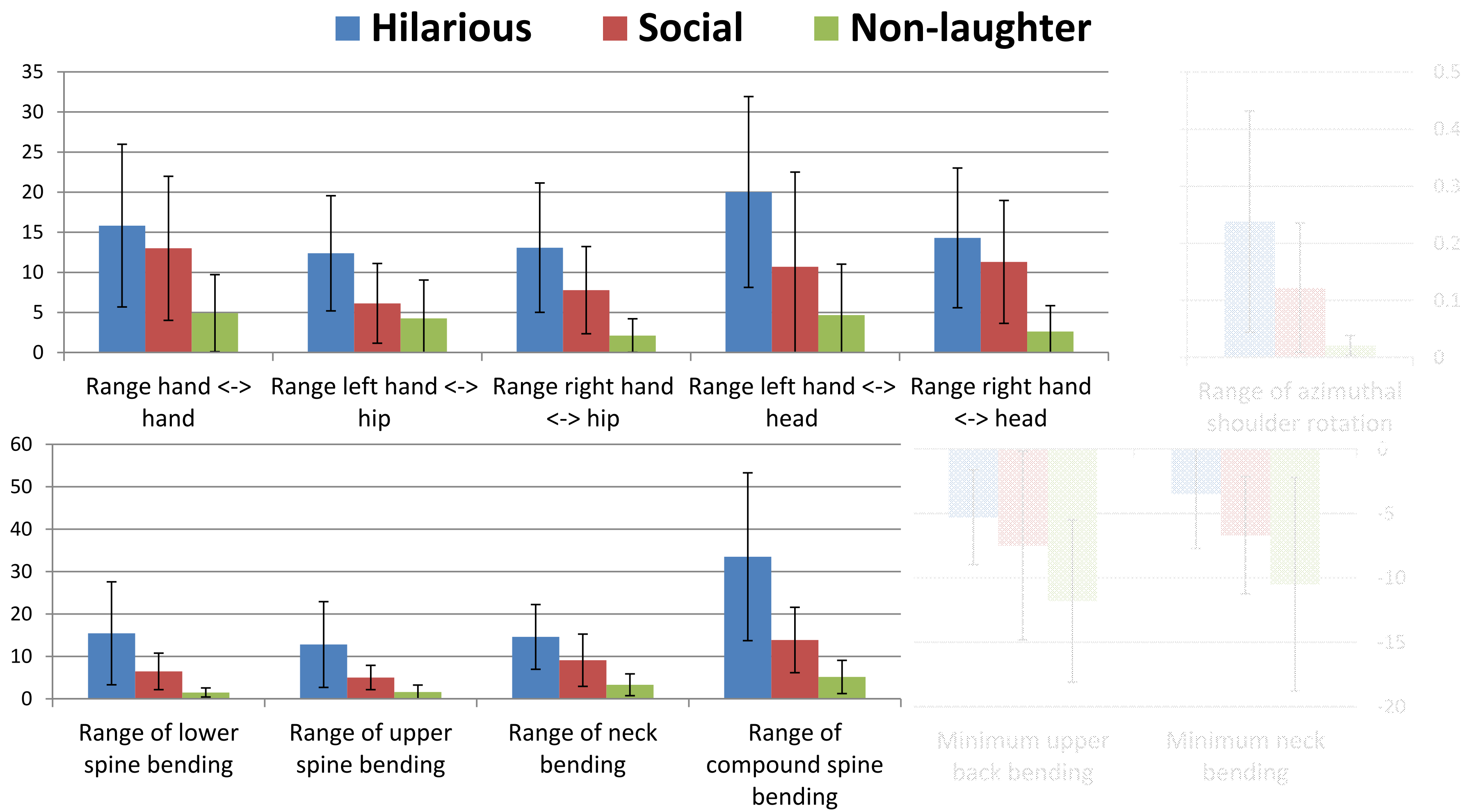
Metrics	Features returning single value for each animation
Movement	Duration
Energy	Energy at elbow joint (max of left and right)
	Energy at shoulder joint (max of left and right)
	Energy at hip joint (max of left and right)
	Energy at knee joint (max of left and right)
	Energy at lower spine joint
	Energy at upper spine joint
	Energy at neck joint
Shoulder rotation	Azimuthal rotation of shoulders in global space
Lower body distances	Ankle trajectory distance (max of left and right)
	Knee trajectory distance (max of left and right)
Smoothness	Smoothness of shoulder trajectory relative to upper spine (mean of left and right)
Displacement	Range of superior-inferior shoulder displacement (mean of left and right)
	Correlation of left and right shoulder superior-inferior displacement
	Power in 4-6Hz band of superior-inferior shoulder displacement (mean of left and right)

Features for Sitting context	MIN	MAX	Range
Distance between hands			a,B
Distance between hands and head			A,B
Distance between hands and hip			A,b
Angle at lower spine joint			A,B,c
Angle at upper spine joint		a,b	A,B,c
Angle at neck joint		a,b	A,B
Sum of all spine angles			A,B,c
Anterior-posterior component of lower spine→upper-spine segment direction			A,B
Anterior-posterior component of upper-spine→neck segment direction			A,B
Anterior-posterior component of neck→head segment direction		a,b	A ,B,c
Lateral component of lower spine→upper-spine segment direction		a,b	A,B
Lateral component of upper-spine→neck segment direction			A,B,c
Lateral component of neck→head segment direction		a,b	A ,B,c
Rotation of shoulders relative to hip line		a,b	A,B,c

Features for Standing context	MIN	MAX	Range
Distance between hands			x,y
Distance between hands and head	x,y		x,y
Distance between hands and hip		x,Y	x,y
Angle at lower spine joint	x,y		X,Y
Angle at upper spine joint	x,y		X,Y,z
Angle at neck joint	y		x,y
Sum of all spine angles	x,y		X,Y
Anterior-posterior component of lower spine→upper-spine segment direction		x,y	X,Y
Anterior-posterior component of upper-spine→neck segment direction		x,y,z	X,Y,z
Anterior-posterior component of neck→head segment direction		x,y	X,Y
Lateral component of lower spine→upper-spine segment direction		x,Y	
Lateral component of upper-spine→neck segment direction		x,y	x,y
Lateral component of neck→head segment direction		x,y	x,y
Rotation of shoulders relative to hip line	X,y,z		

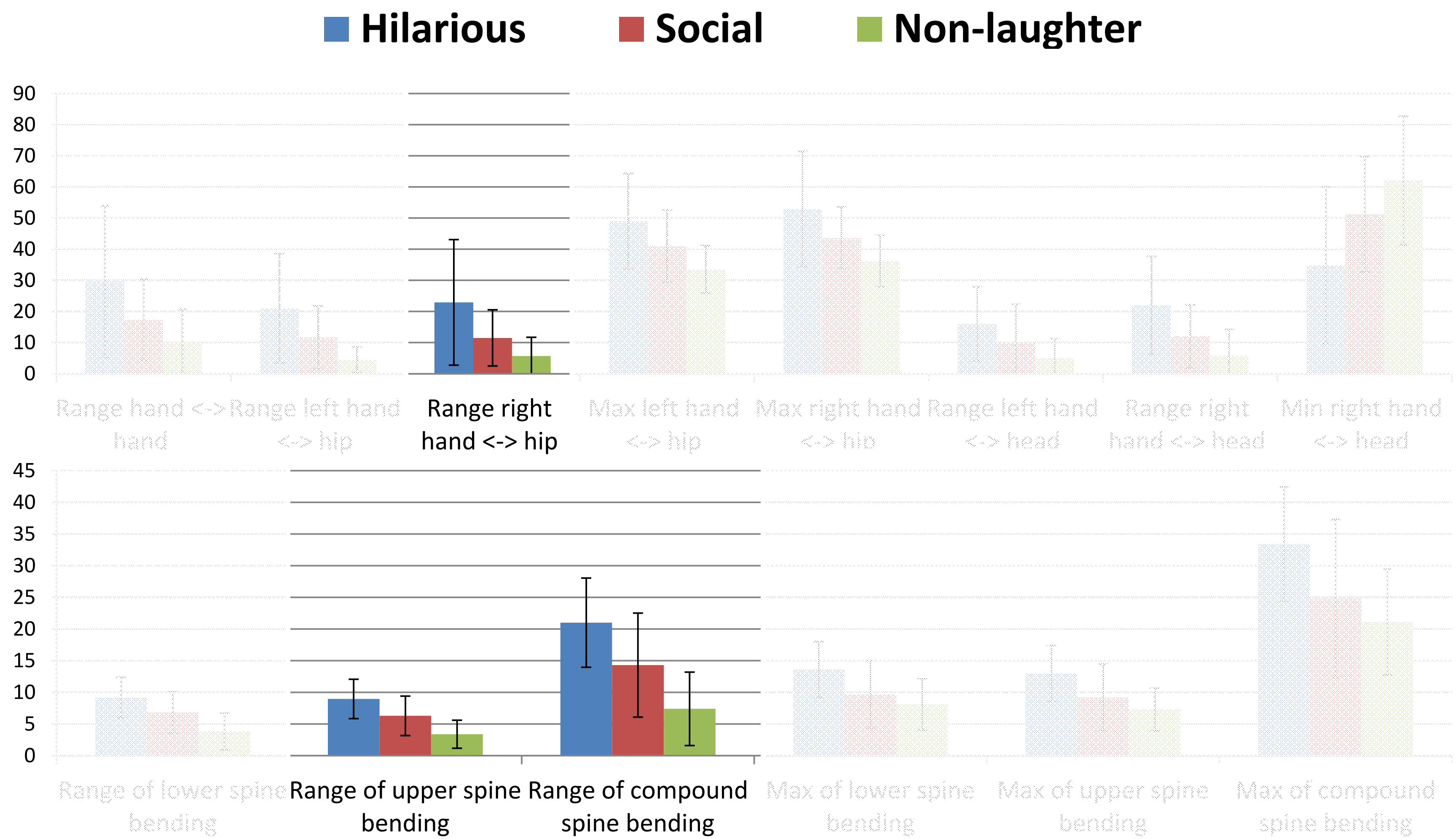
Features returning single value for each animation	Sitting	Standing
Duration	A,B	y
Energy at elbow joint (max of left and right)		
Energy at shoulder joint (max of left and right)	A,B,c	X,y,Z
Energy at hip joint (max of left and right)	a,b,c	
Energy at knee joint (max of left and right)	b,c	
Energy at lower spine joint	a,b,c	x
Energy at upper spine joint	a,b	x,y
Energy at neck joint	A,B,c,x,y	
Azimuthal rotation of shoulders in global space	A,B	
Ankle trajectory distance (max of left and right)	a,B,c	
Knee trajectory distance (max of left and right)	A,B,C	x,y,z
Smoothness of shoulder trajectory relative to upper spine (mean of left and right)	a	
Range of superior-inferior shoulder displacement (mean of left and right)	A,B	
Correlation of left and right shoulder superior-inferior displacement		
Power in 4-6Hz band of superior-inferior shoulder displacment (mean of left and right)		

LAUGHTER| Sitting: discriminative body features

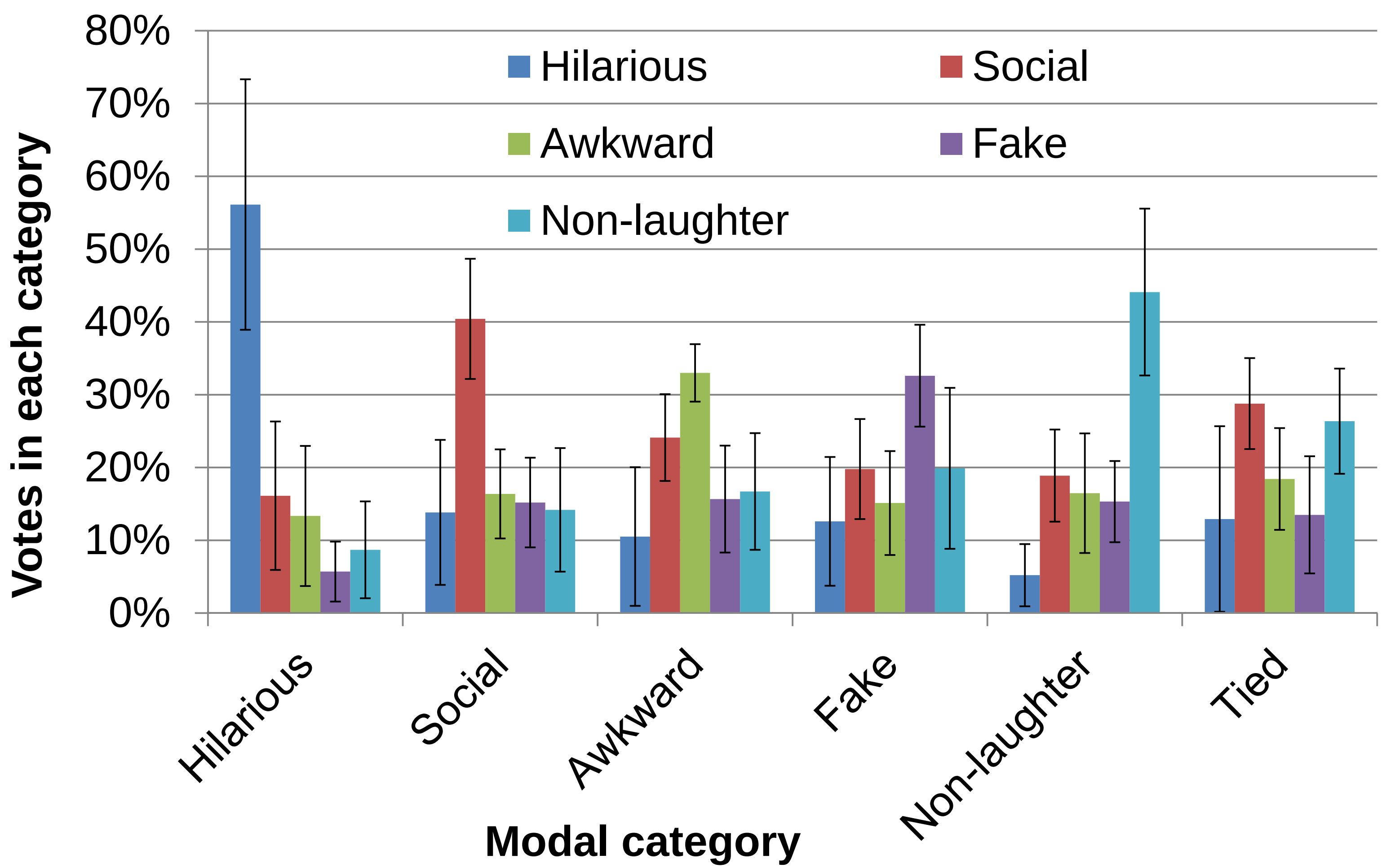


UCLIC

LAUGHTER| Standing: discriminative body features



LAUGHTER| Modal category and Label distribution



LAUGHTER TYPES| Modeling and evaluation

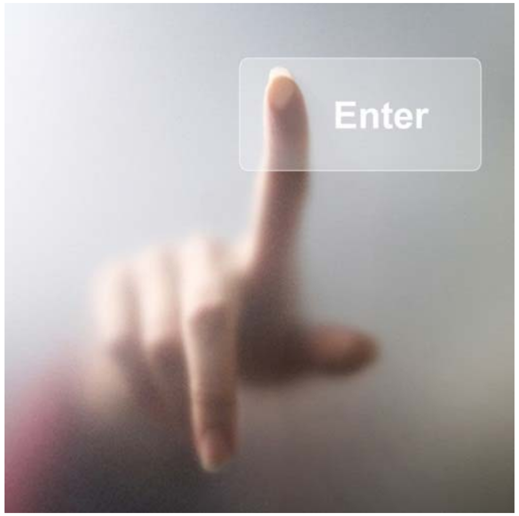
Short name	ML Algorithms
(K)SVR	Linear and Kernel Support Vector Regression
k-NN	*k*-Nearest Neighbour
MLP	Multi Layer Perceptron with Softmax
RF	Random Forest
LASSO	Least Absolute Shrinkage and Selection Operator

Short name	Error metrics
MSV	Mean Square Error
CS	Cosine Similarity
TMR	Top Match Rate
RL	Ranking Loss: this metric calculates the average fraction of label pairs that are reversely ordered for an instance.

LAUGHTER TYPES| Automatic recognition

	MSE ↓	*CS* ↑	*TMR* ↑	*RL*↓
k-NN	0.015 (0.005)	0.89 (0.04)	0.52 (0.21)	0.30 (0.05)
RR	0.015 (0.005)	0.89 (0.03)	0.44 (0.20)	0.29 (0.07)
KRR	0.017 (0.008)	0.87 (0.05)	0.45 (0.21)	0.31 (0.07)
SVR	0.014 (0.005)	0.89 (0.03)	0.50 (0.18)	0.29 (0.08)
KSVR	0.015 (0.006)	0.89 (0.04)	0.49 (0.15)	0.30 (0.05)
LASS0	0.015 (0.005)	0.89 (0.03)	0.43 (0.22)	0.30 (0.08)
MLP	0.017 (0.007)	0.87 (0.05)	0.50 (0.18)	0.32 (0.05)
ARD	0.016 (0.006)	0.88 (0.04)	0.50 (0.17)	0.31 (0.05)
RF	**0.010 (0.003)**	**0.92 (0.03)**	**0.59 (0.18)**	**0.26 (0.06)**
Observers	0.02 (0.003)	0.95 (0.01)	0.85 (0.03)	0.10 (0.01)

What can touch tell us about emotions in touch-based gameplay



Gao, Bianchi-Berthouze, Meng, What does touch tell us about emotions in touchscreen-based gameplay?, ACM Transaction on CHI, in press

TOUCH| Do we communicate emotions through touch?

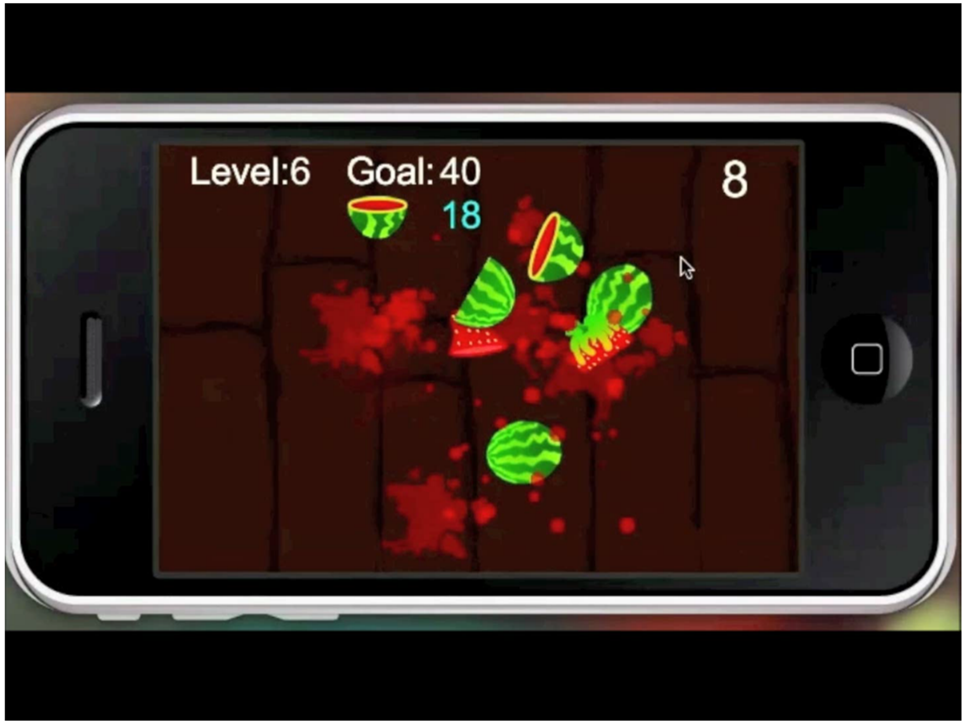
- People discriminate between acted affective touches (Hertenstein et al. 2009)
  - Love, sympathy, fear, disgust, happiness, sadness, anger
  - Recognition between 50%-80%

- Clynes (sentography, 1973) showed the existence of vertical and horizontal finger-pressure profiles for different emotions.

- Khanna et al. (2010) and Lv et al. (2008) showed that keyboard typing behaviour is affected by the user's emotional state.
  - frequency of selection of certain keys (e.g. backspace)
  - positive mood increases typing speed
  - pressure shown to be a very discriminative features

- Automatic detection of affect through 2 DoF force feedback joysticks (Bailenson et al. 2007).
  - Acted expressions: Participants communicated anger, disgust, fear, interest, sadness and surprise to another person.

TOUCH| Data Collection of swipe behaviour

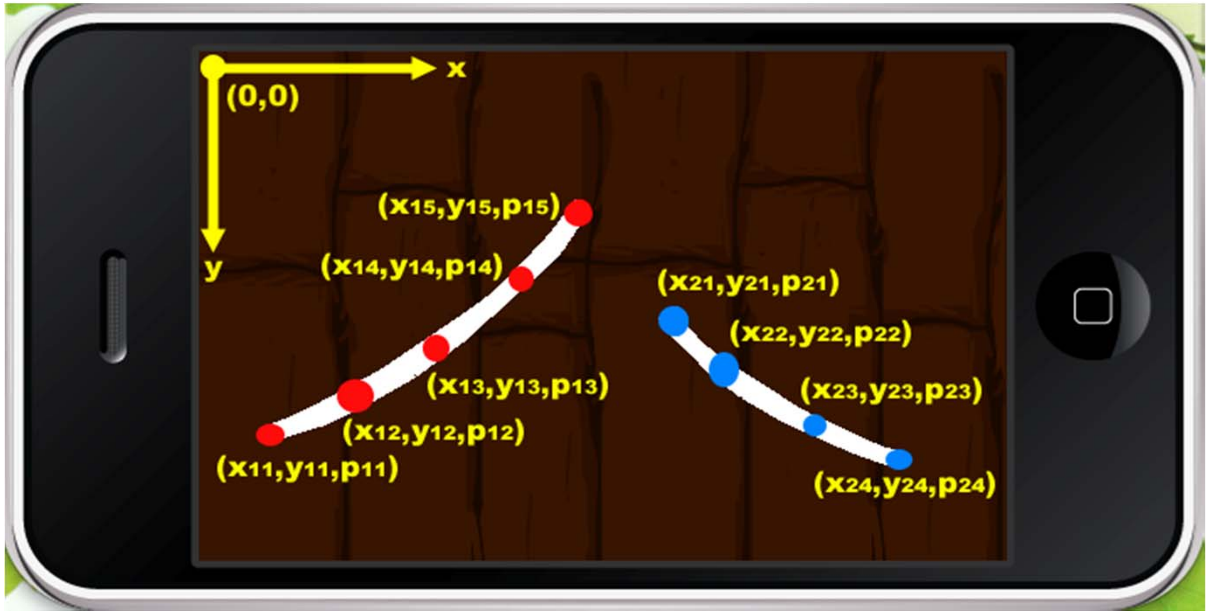


- Touch behaviour:
  - Players slash the fruits one by one or wait for multiple fruits to be lined up and slash them at once.

- Adapted version of Samurai Fruit .... Or Ninja Fruit game
  - 20 sessions of 30 sec.
  - A session is won if a target number of points are made.

- Difficulty of game increases between sessions:
  - Increased speed of objects
  - Increased number of bombs per number of fruits

TOUCH | Swipe behaviour features

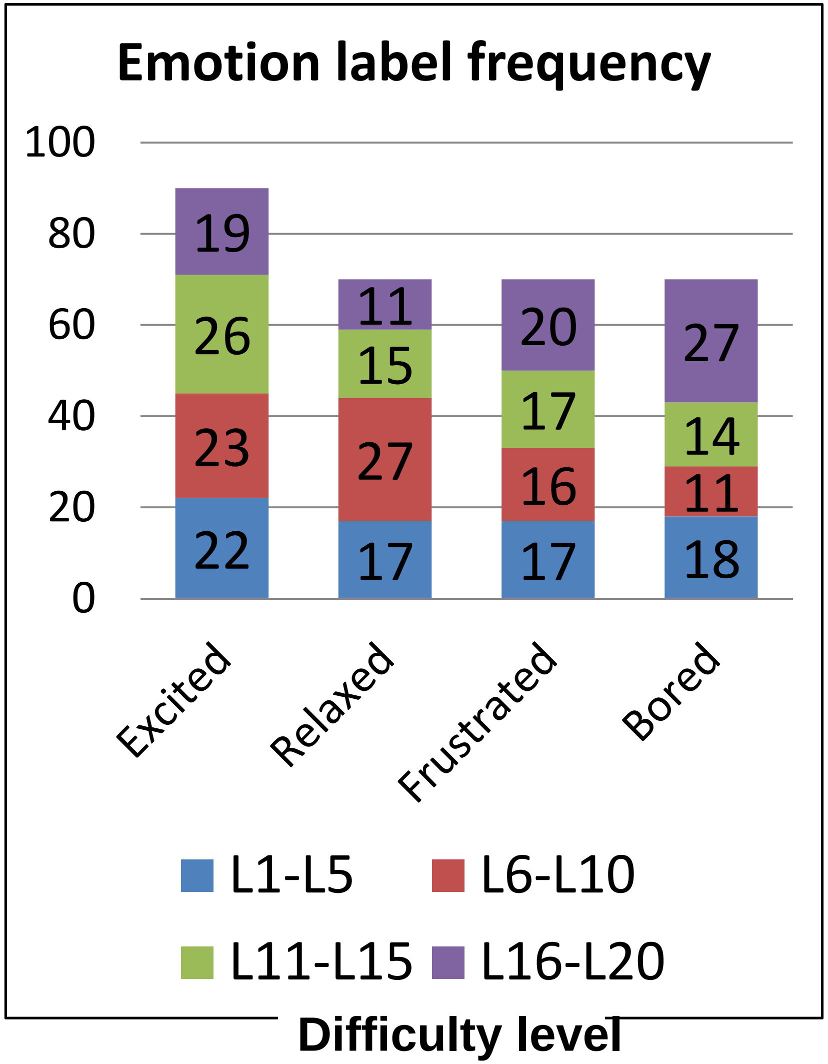


- The software captures and stores players' finger-stroke behaviour
  - Coordinates of each point of a stroke
  - Contact area (to simulate pressure) of the finger at each point
  - Duration: time of finger contact and time of finger lift.

UCLIC

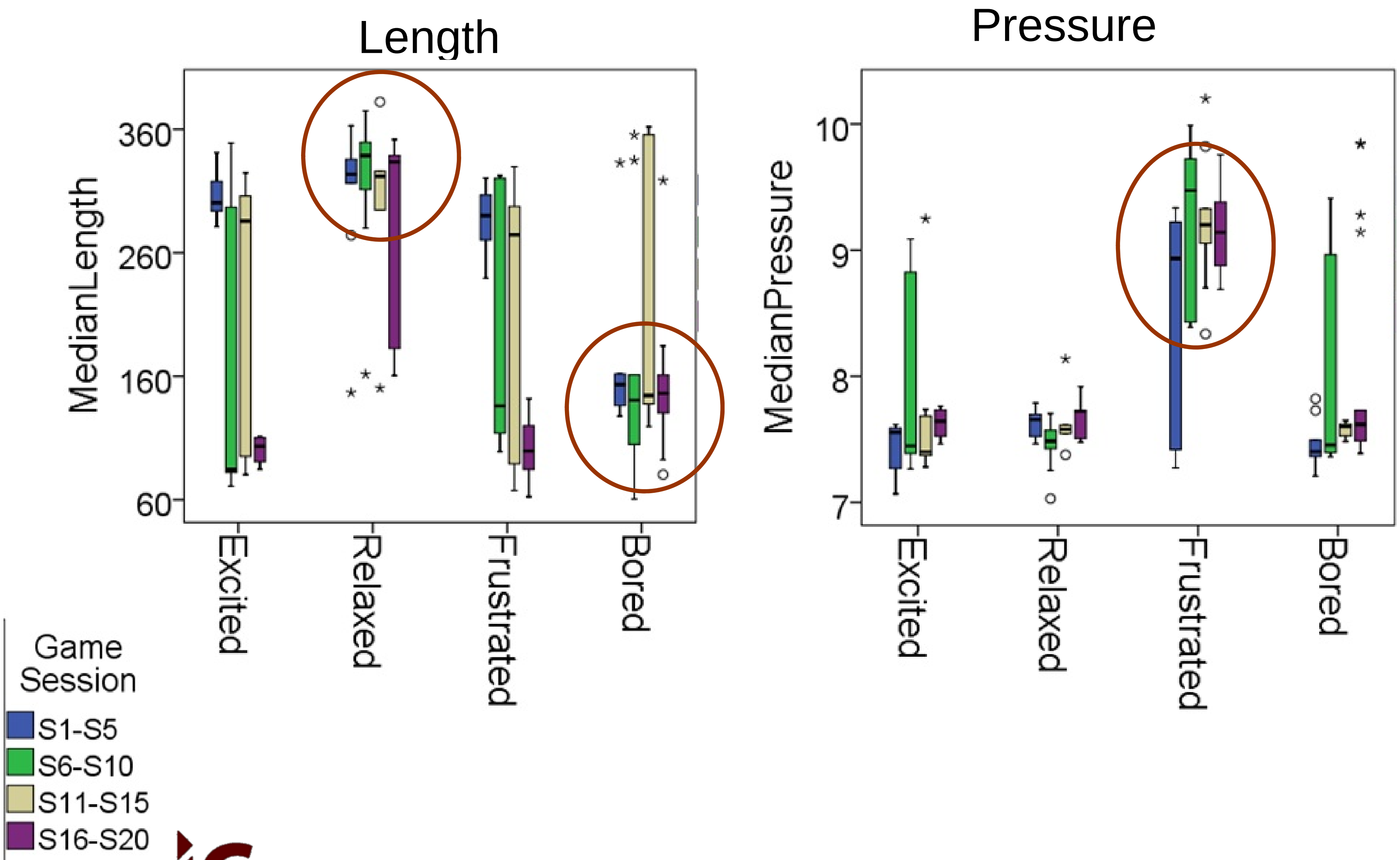
TOUCH | Participants and collected data

- 15 participants :
  - 9 male and 6 female, age: 18 - 40
  - One participant play the game twice.
- Swipe behaviour were recorded and averaged over each level
  - Length, duration, speed, DI
  - Average, median, max, min
- 300 game-levels data were finally used
  - the data from the participant that played twice were selected to balance the data.



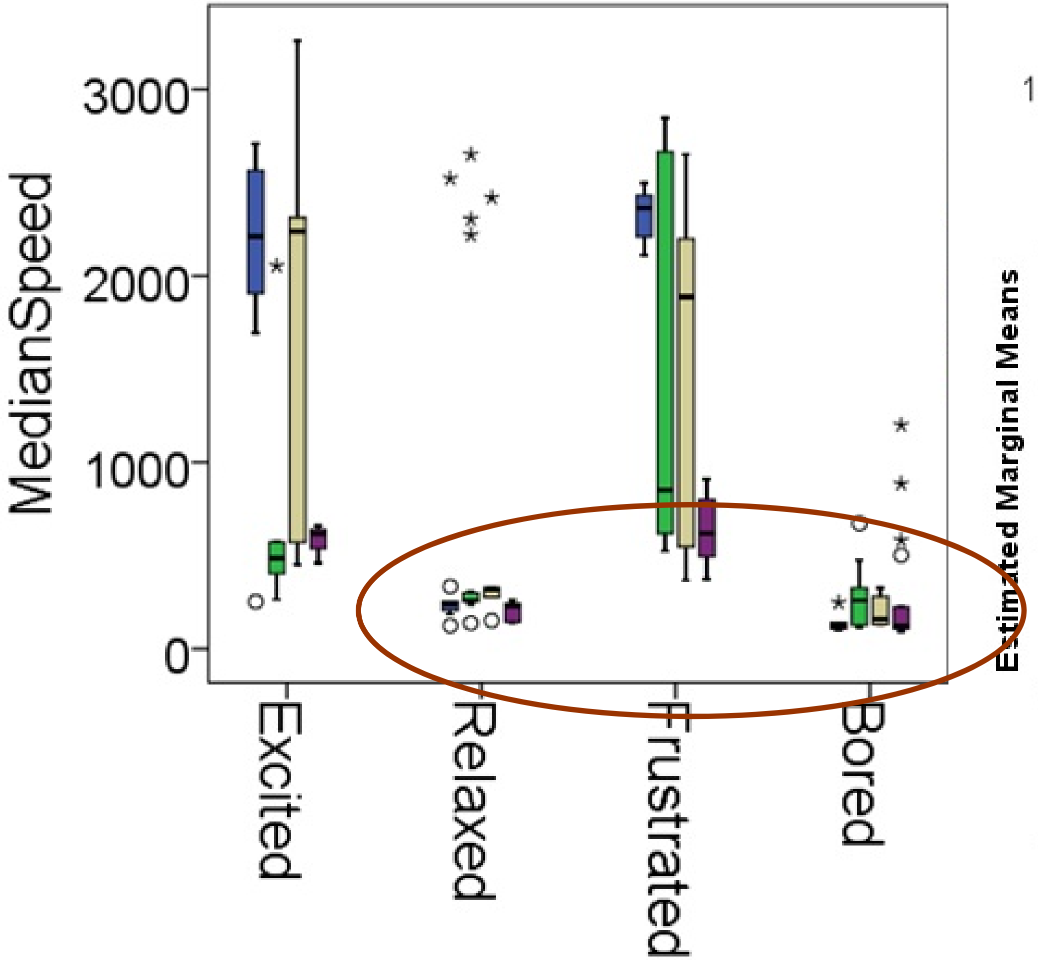
UCLIC

TOUCH| Results: Emotion & Touch behaviour

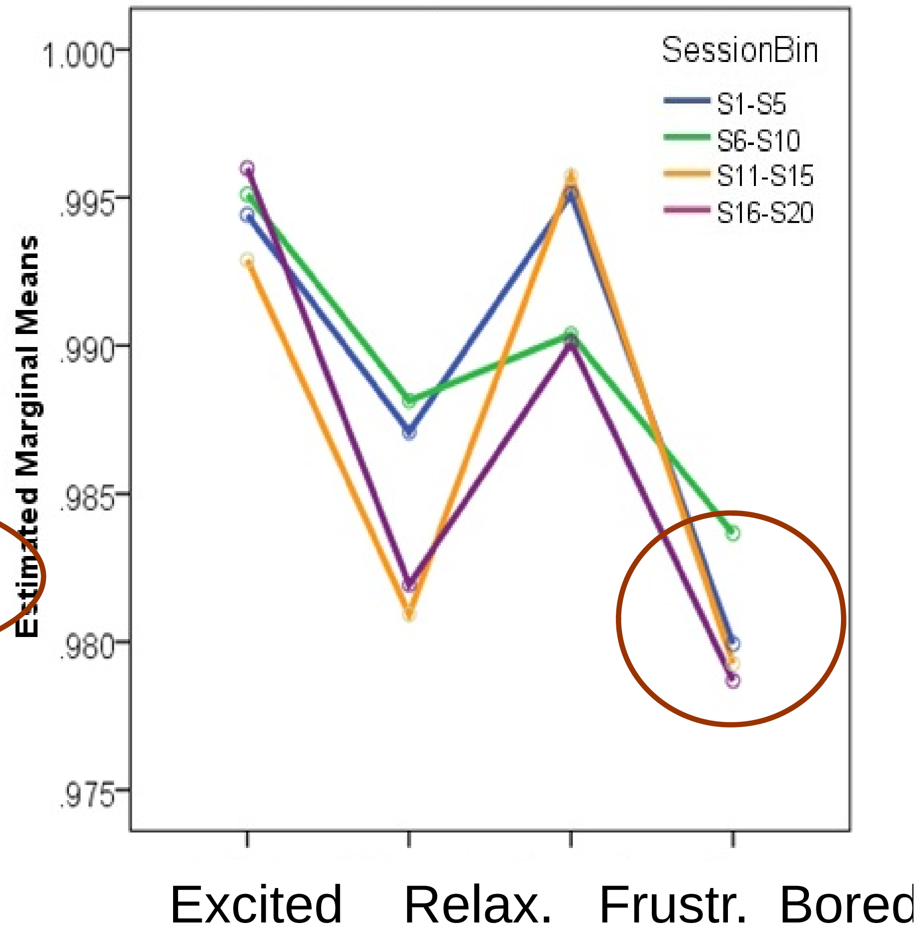


RESULTS| Results: Emotion & Touch behaviour

Speed

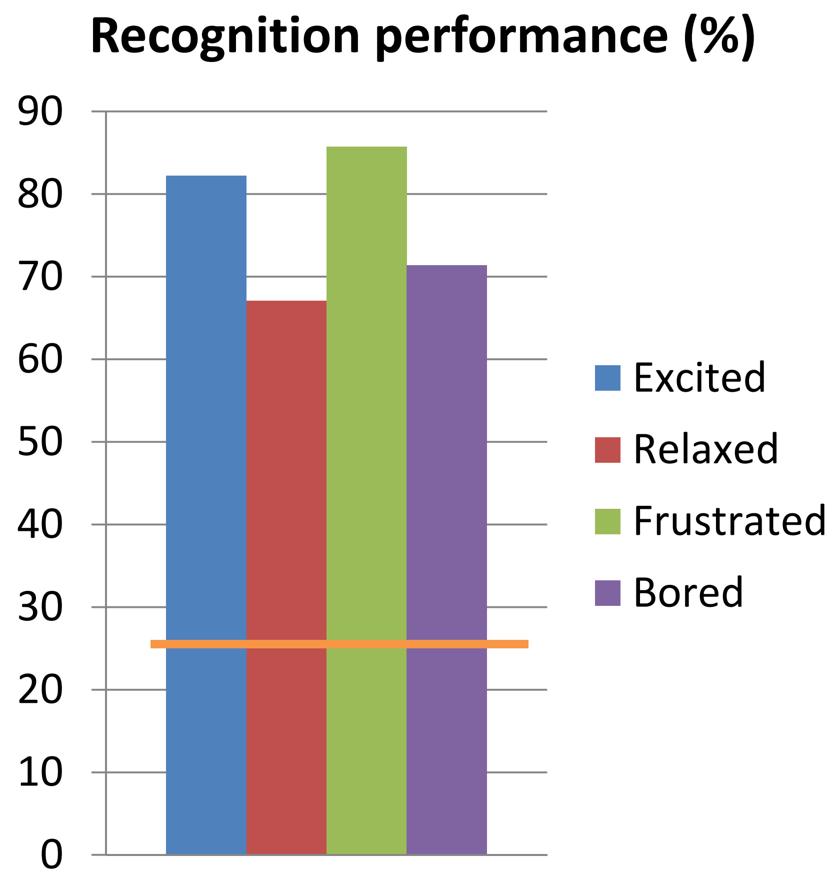


Directness Index



TOUCH| Automatic categorization of swipe behaviour

- Test for generalization over people
  - Cross-Validation
  - Leave-one-person-out
- Various classifiers:
  - DA, ANN, Linear SVM, Kernel SVM



Gao, Y., Bianchi-Berthouze, N., Meng, H. (2012). What Does Touch Tell Us about Emotions in Touchscreen-Based Gameplay? *ACM Transactions on Computer - Human Interaction* 19(4), 31

TECHNOLOGY (3)| Emotion regulation

Can we design technology that uses your body to change your experience?

POWER POSE

LOW POWER POSE

What does your body tell me ….
Oh, … and what does it tell you?

Body postures and movements influence people's feelings and thoughts

- Perceptions of ourselves and others
- Attitudes towards products and events

by S. Yates

Niedenthal, et al., Personality and Social Psychology Review, 2005
Carney, Cuddy, et al. Power posing: Brief nonverbal displays affect neuroendocrine levels and risk tolerance. *Psychological Science, 2010*

TECHNOLOGY (3)| Emotion and Affordance of technology

Body movements affect the emotional experience through proprioceptive feedback

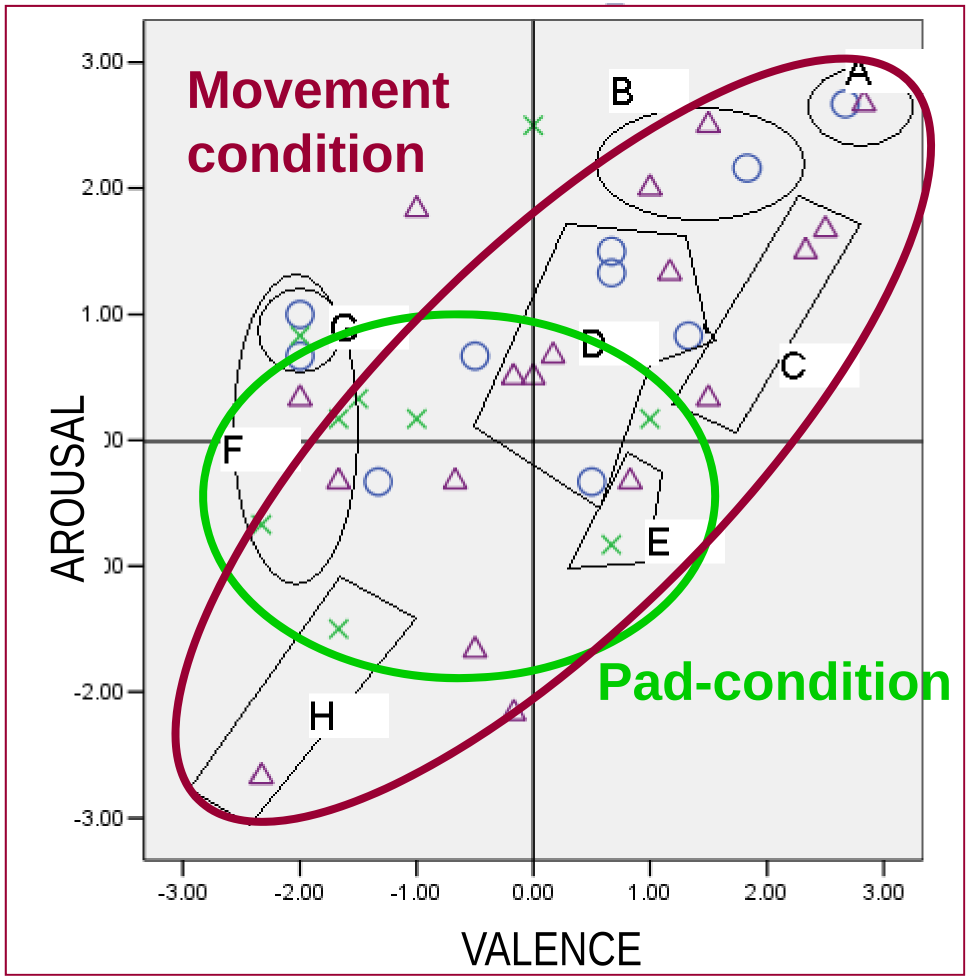
- Bianchi-Berthouze, Understanding the role of body movement in player engagement. *Human-Computer Interaction*, 2012
- Nijhar, J., Bianchi-Berthouze, N., Boguslawski, G. (2012). Does Movement Recognition Precision affect the Player Experience in Exertion Games? *(INTETAIN)*. (Vol. LNICST 78 pp.73-82)

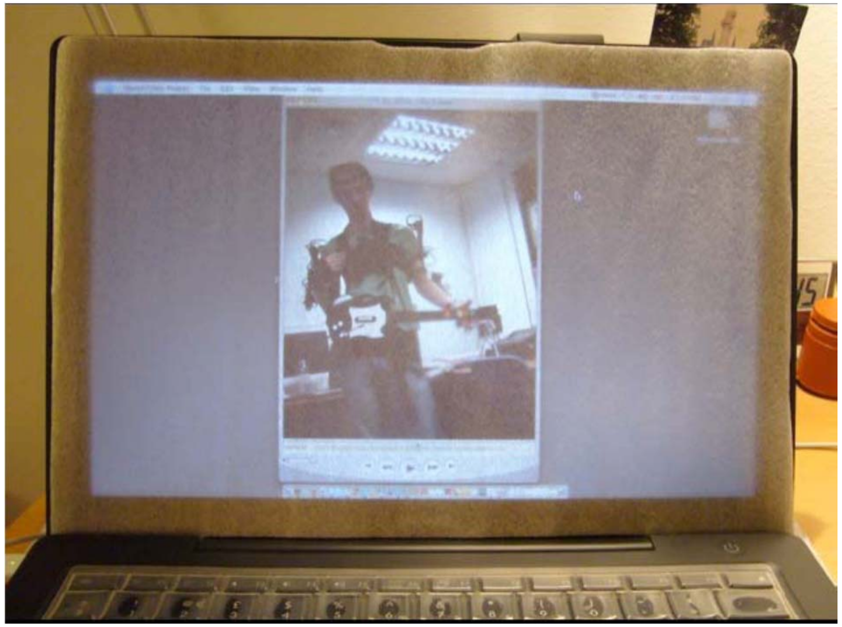
TECHNOLOGY (3)| Affordance of technology

• **Guitar Hero I™ guitar shaped controller (Credit: RedOctane© 2005)**

UCLIC

TECHNOLOGY (3)| Emotional experience

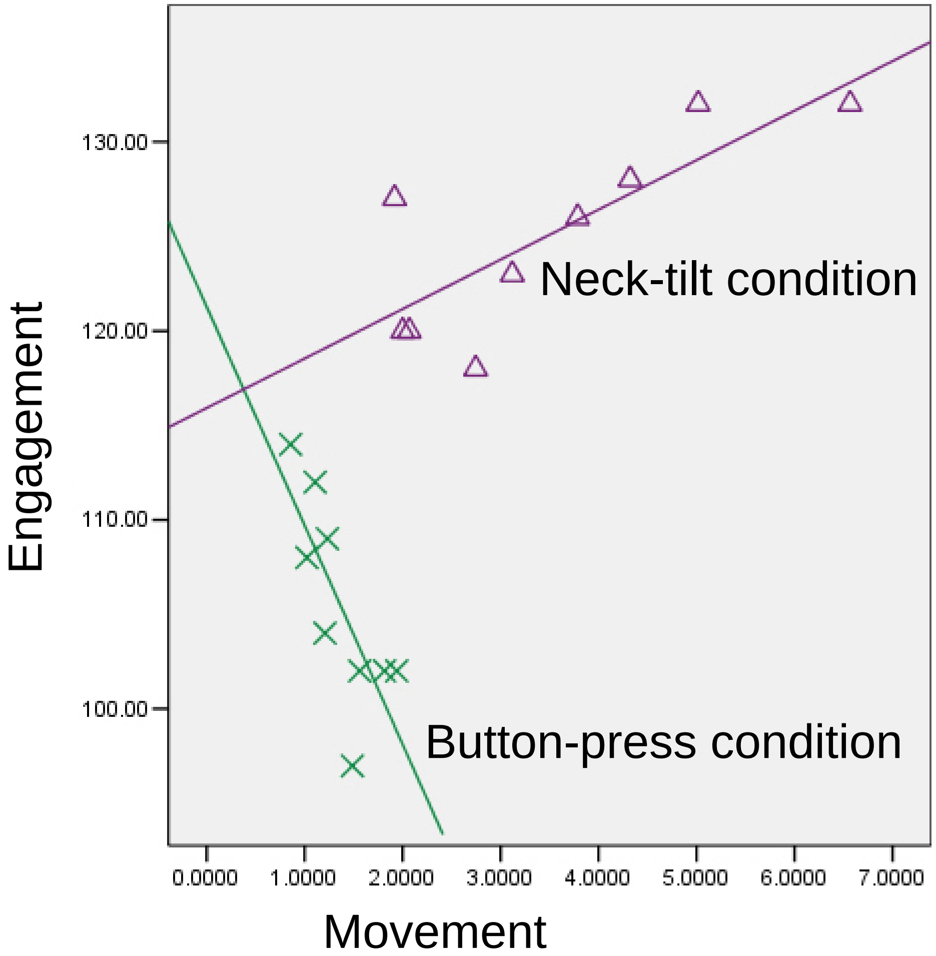




Cluster	Body Gestures	Affective Labels
A	Raising arms up to mid air	Excited, joyful, happy
B	Dancing	Excited, content, aroused
C	Thumbs-up and arm bent	Happy, satisfied, joyful
D	Leaning back and shaking body	Amused, excited, happy, content, surprised, satisfied
E	Shaking head	Relaxed, content satisfied
F	Dropping arms	Disappointed, frustrated, calm
G	Shaking/shivering body while leaning back	Disappointed, frustrated
H	**Very little movement**	Bored, disappointed

UCL

TECHNOLOGY (3)| Emotional experience



In the neck-tilt condition:

larger presence of positive affective expressions ($p < 0.0001$) and rhythmic movements such as dancing ($p < 0.005$)

i.e., movements not necessary to control or to, facilitate the task …

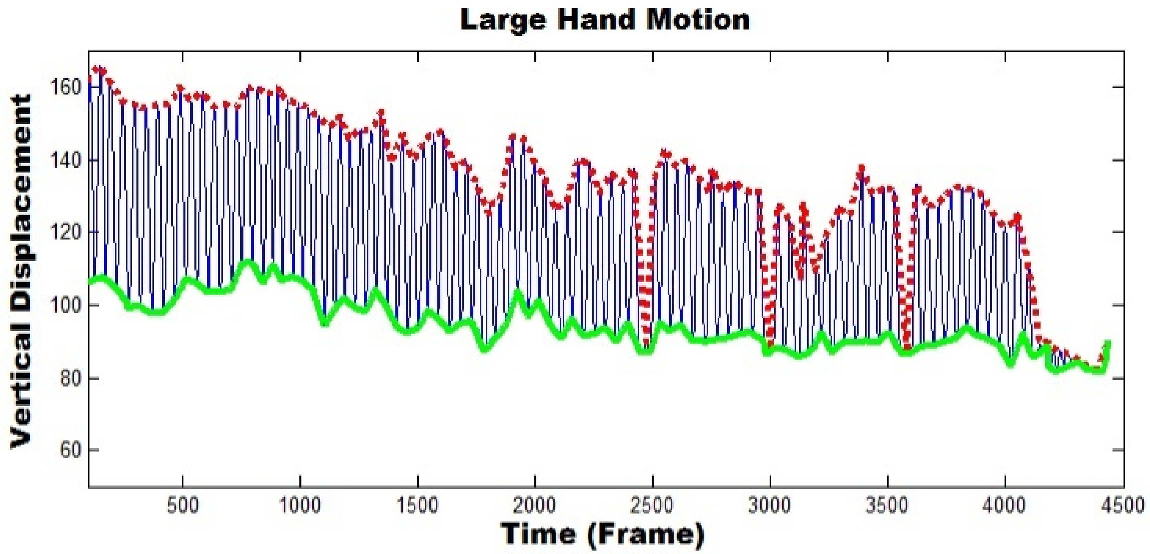
UCLIC

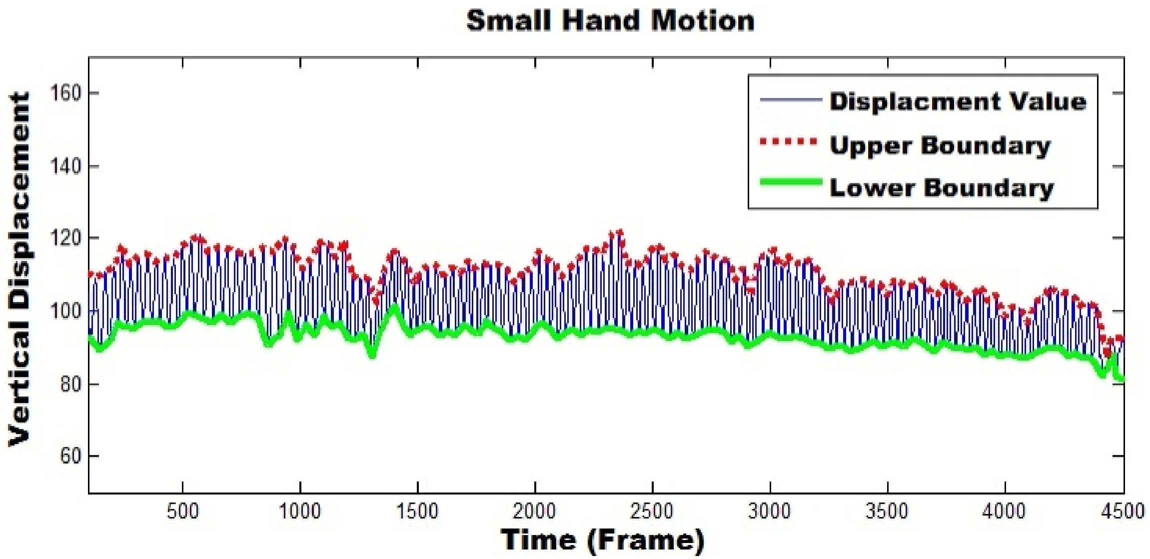
EXPERIMENT 4| Effect of qualities of movement

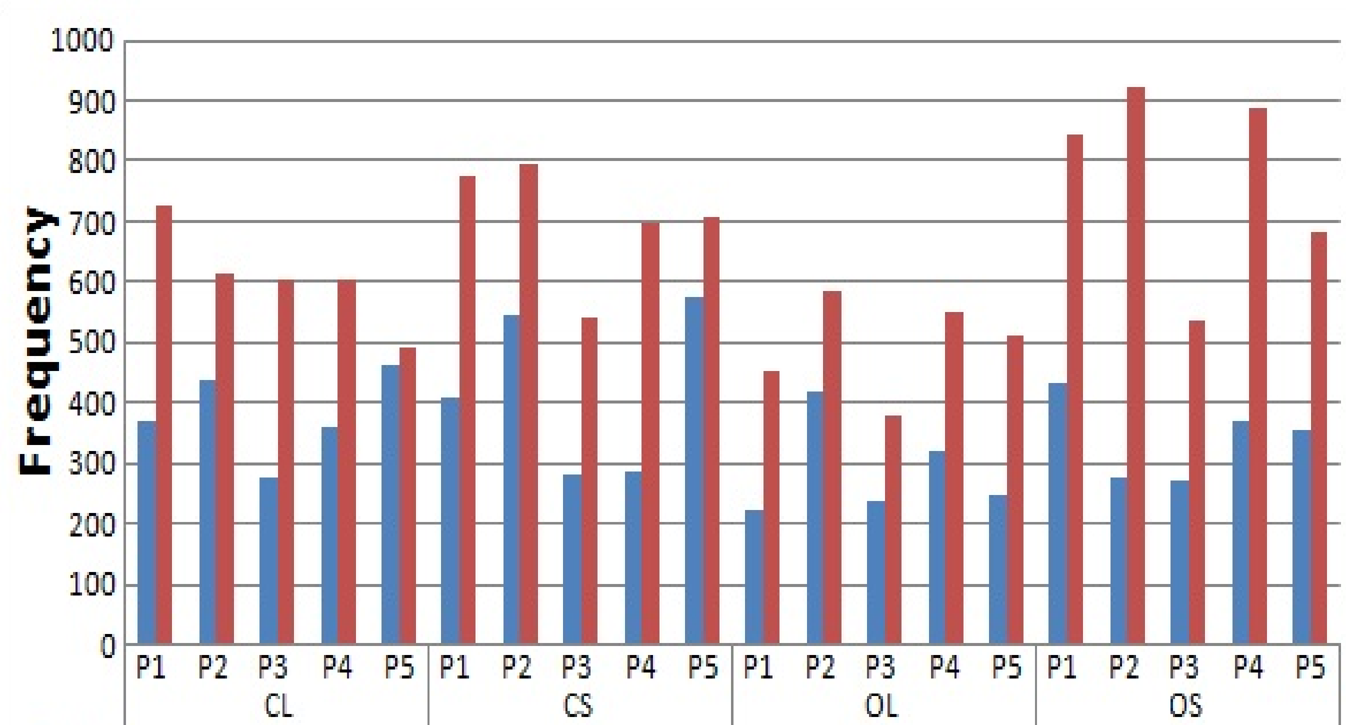
Systematic analysis of effect of movement quality over emotional experience

- 8 combinations of gesture qualities: close vs. openness, large vs. small, jerky vs. fluid

UCLIC


Large Hand Motion
Vertical Displacement
160
140
120
100
80
60
500
1000
1500
2000
2500
3000
3500
4000
4500
Time (Frame)


Small Hand Motion
Vertical Displacement
Displacment Value
Upper Boundary
Lower Boundary
160
140
120
100
80
60
500
1000
1500
2000
2500
3000
3500
4000
4500
Time (Frame)



	CL P1	CL P2	CL P3	CL P4	CL P5	CS P1	CS P2	CS P3	CS P4	CS P5	OL P1	OL P2	OL P3	OL P4	OL P5	OS P1	OS P2	OS P3	OS P4	OS P5
Fluid	367	438	277	358	460	409	544	280	288	575	224	420	237	319	246	434	274	269	368	354
Jerky	727	612	604	606	490	774	797	538	695	709	450	582	377	548	510	844	922	537	886	681

TECHNOLOGY| Results on quality of movements

- Size:
  - Large vs. Small gestures: higher arousal, valence, dominance
- Jerkiness:
  - Jerky vs. Fluid gestures: higher arousal
- Valence: Interaction size x jerkiness:
  - Large fluid vs Large jerky: higher valence
  - Small fluid vs. Small jerky: lower valence
- No effect for openness

Walsh, Bianchi-Berthouze, Aung, IEEE Trans. On Affect. Comp., in preparation

TECHNOLOGY (3)| Movement as emotion-biasing mechanism

- Triggering mechanisms:
  - Task control
  - Task facilitating

Can be designed to
- facilitate role taking
- trigger suitable emotions

- Reinforcing mechanisms:
  - Role-taking
  - Emotional expressions
  - Social facilitator

Can be designed to enable such expressions
- Multi-sensory feedback?

SUMMARY

- There is more than correction, boredom and fun when designing for rehabilitation
  - Emotions may be a barrier to rehabilitation
  - Barriers may vary from person to person
- Technology's role:
  - from monitoring to teaching skills
  - discovering pleasure

SUMMARY

- Affect-awareness is needed for effective support
  - What modalities?
  - Where are we?
  - How accurate should these system be?

- Movement as an emotional-bias mechanism

Thanks

- H. Aung
- H. Griffin
- B. Romera-Paredes
- A. Singh
- T. Olugbade

- M. Hongying
- A. Kleinsmith

Collaborators

- A. Williams
- M. Pantic's group
- P. Watson
- G. McKeown
- M. Pontil
- W. Curran

UCL EPSRC NHNN SEVENTH FRAMEWORK PROGRAMME