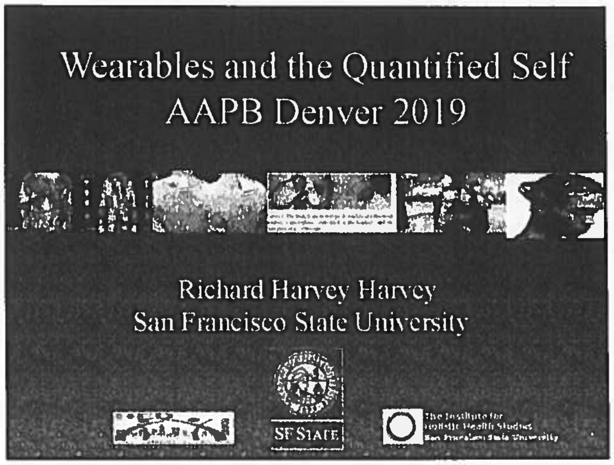
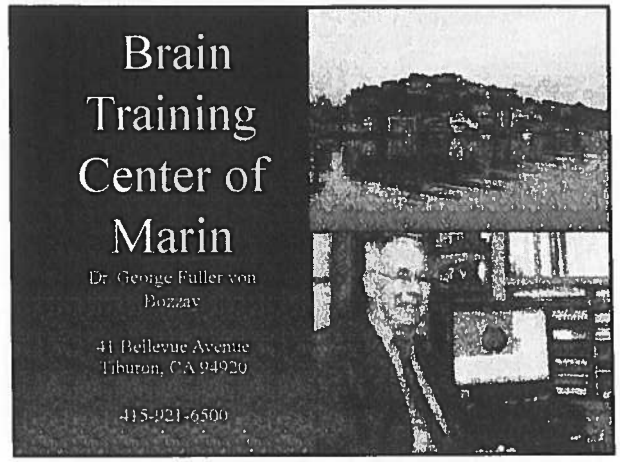
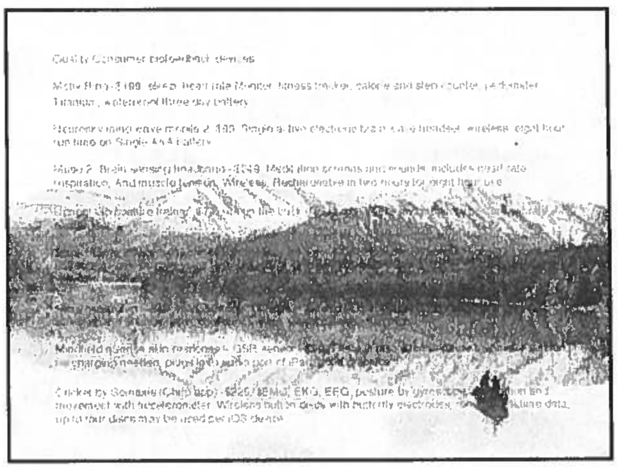
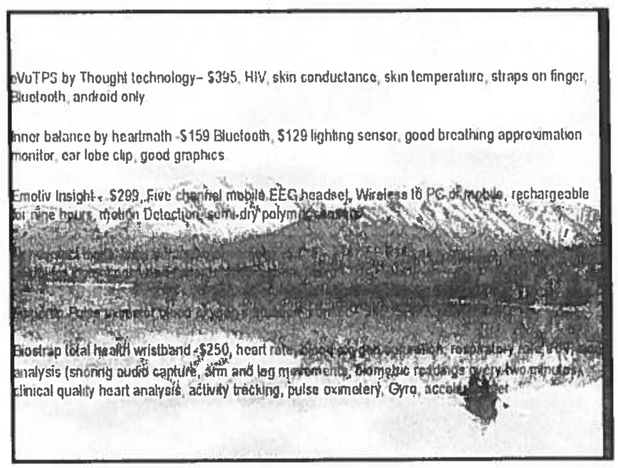
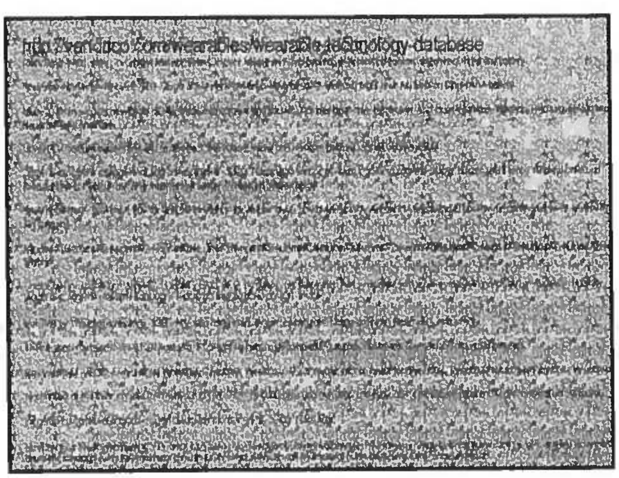
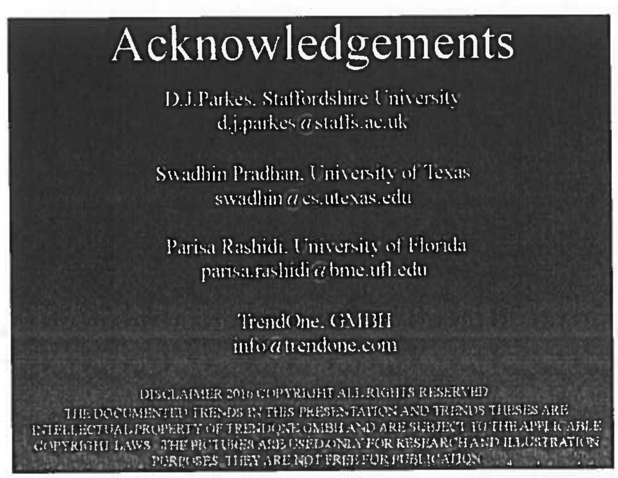

Wearables and the Quantified Self
AAPB Denver 2019
Richard Harvey Harvey
San Francisco State University
SF STATE
The Institute for Holistic Health Studies
San Francisco State University


Brain Training Center of Marin
Dr. George Fuller von Bozzay
41 Bellevue Avenue
Tiburon, CA 94920
415-921-6500


Quality Consumer biofeedback devices


eVuTPS by Thought technology– $395, HIV, skin conductance, skin temperature, straps on finger, Bluetooth, android only
Inner balance by heartmath -$159 Bluetooth, $129 lighting sensor, good breathing approximation monitor, ear lobe clip, good graphics
Emotiv Insight - $299, Five channel mobile EEG headset, Wireless to PC or mobile, rechargeable for nine hours, motion Detection, semi-dry polymer sensors
Biostrap total health wristband -$250, heart rate,
analysis (snoring audio capture, arm and leg movements, biometric readings every two minutes,
clinical quality heart analysis, activity tracking, pulse oximetery, Gyro, accelerometer


database


Acknowledgements
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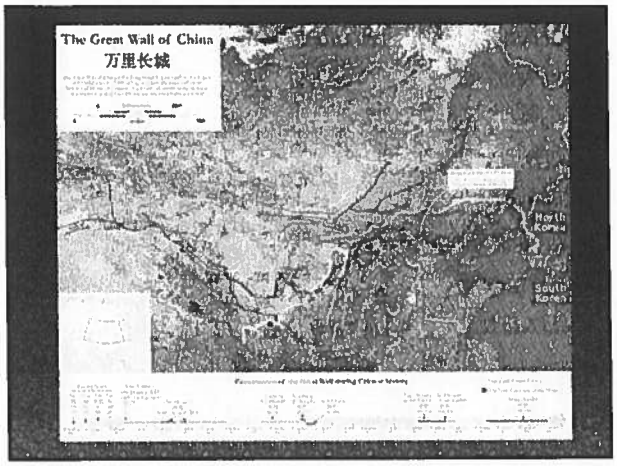


Theoretical Issues: Observations

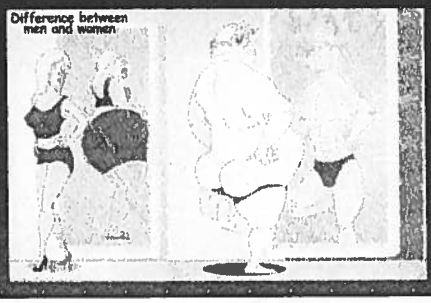
In addition to training reductions in physical reactivity, biofeedback training must also acknowledge individual learning styles and train for reducing cognitive and behavioral reactions as well.

Biofeedback training should be aware of philosophical and methodological fallacies related to:

1. Feedback Accuracy
2. Mislabeling
3. Raising the Question
4. Over Generalizations

Feedback Accuracy

1) Acknowledging individual self-perceptions are essential in biofeedback training.



Mislabeling

2) Verbal fallacies* may arise from mislabeling a our terms or medical conditions

'What a beautiful belt you've got on!' Alice suddenly remarked. 'At least,' she corrected herself on second thoughts, 'a beautiful cravat, I should have said -- no, a belt, I mean -- oh, I beg your pardon!' she added in dismay, for Humpty Dumpty looked thoroughly offended, and she began to wish she hadn't chosen the subject. ' If only I knew,' she thought to herself, ' which was neck and which was waist!'**

Raising the Question

3) Begging the question fallacies* arise when we 'find what we are looking for' and stop considering other options that are more true for the client

The Hunting of the Snark!

"Just the pLace for a Snark!" the Bellman cried,
As he landed his crew with care;
Supporting each man on the top of the tide
By a finger entwined in his hair.

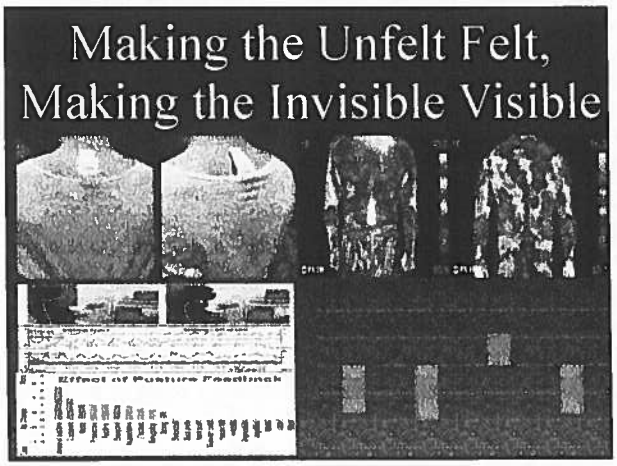
"Just the place for a Snark!
I have said it twice:
That alone should encourage the crew.
Just the place for a Snark! I have said it thrice:
What I tell you three times is true."

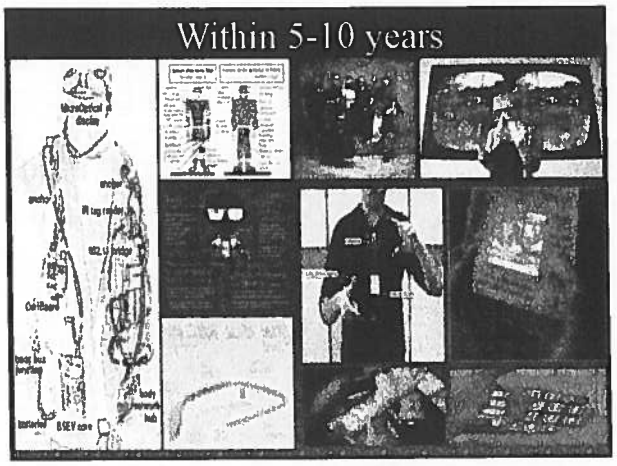
Over-generalization

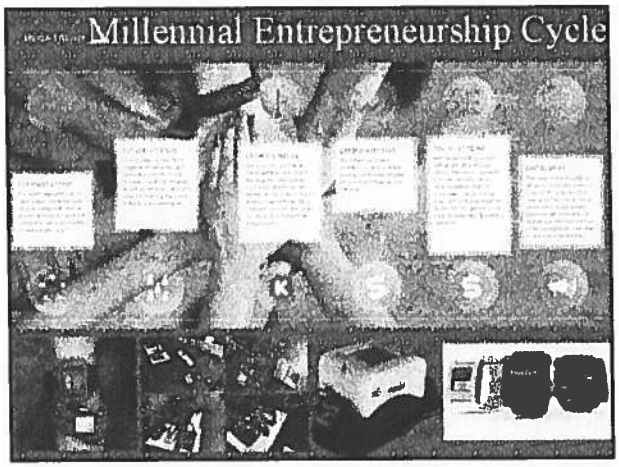
4) Over-generalization fallacies* arise when we attribute some state in the brain to abstract constructs like associated with cognitions or behaviors. Consider the following quote:

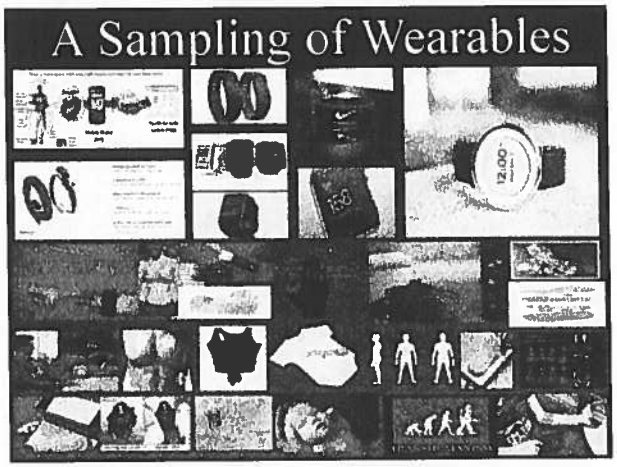
"In conclusion, our findings detail activity associated with cognitively driven sympathetic relaxation facilitated by biofeedback of ElectroDermal Activity (EDA), and implicate a matrix of cortical and subcortical brain regions in mediating the intergration of bodily states of arousal and cognitive and perceptual processing."

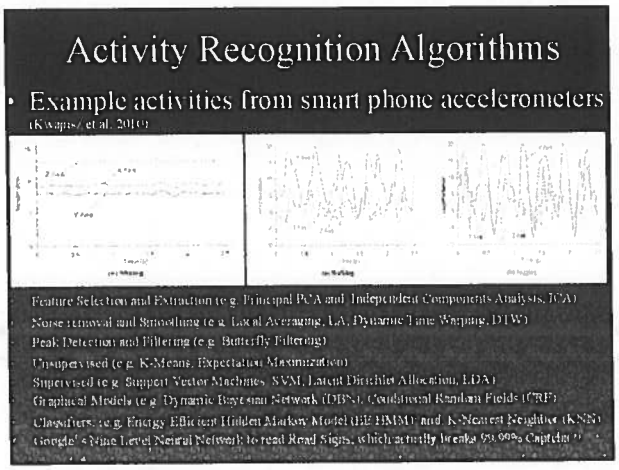
Critchley et al., Neuroimage, 16: 909-919, 2002 Volitional control of autonomic arousal: a functional magnetic resonance study

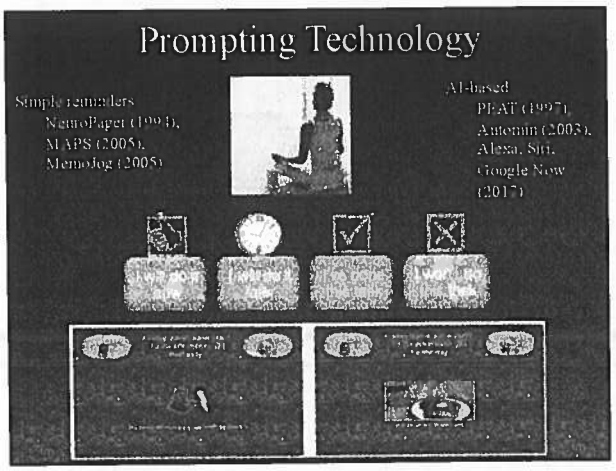

Making the Unfelt Felt,
Making the Invisible Visible


Within 5-10 years


Millennial Entrepreneurship Cycle


A Sampling of Wearables


Activity Recognition Algorithms
• Example activities from smart phone accelerometers
(Kwapisz et al. 2010)
Feature Selection and Extraction (e.g. Principal PCA and Independent Components Analysis, ICA)
Noise removal and Smoothing (e.g. Local Averaging, LA, Dynamic Time Warping, DTW)
Peak Detection and Filtering (e.g. Butterfly Filtering)
Unsupervised (e.g. K-Means, Expectation Maximization)
Supervised (e.g. Support Vector Machines, SVM, Latent Dirichlet Allocation, LDA)
Graphical Models (e.g. Dynamic Bayesian Network (DBN), Conditional Random Fields (CRF)
Classifiers (e.g. Energy Efficient Hidden Markov Model (EE HMM) and K-Nearest Neighbor (K-NN)
Google's Brain Level Neural Network to read Read Signs, which actually breaks 93.00% Captcha


Prompting Technology
Simple reminders
NeuroPaget (1994),
MAPS (2005),
Memodog (2005)
AI-based
PEAT (1997),
Autominder (2003),
Alexa, Siri,
Google Now
(2017)

Some Other Functional Applications

Cognitive Orthotics
- Reminders
- Planners
- Navigation and stray prevention

Health Monitoring
- Continuous Monitoring of Vital Signs
- ADL
- Sleep Monitoring

Therapy & Rehabilitation
- Tele-Health

Emergency Detection
- Fall Detection
- Medical emergency

Emotional Wellbeing
- Social Connectedness
- Facilitating Communication

Polygraphic Data


Thought Technology eVu TPS and, Biograph Infiniti


Biopac Mobita and, MP150

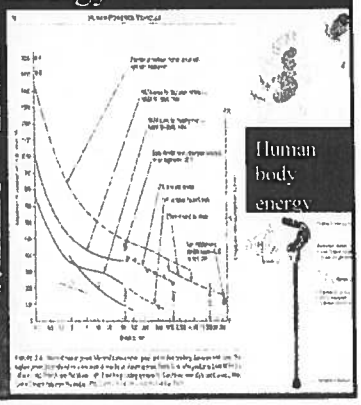

Mind Media NeXus32, NeXus 10MkII and PIP

Energy

- Less is More: SenseLess (Fehmi et al)

Wide Local Building Area Networks WLBANs

École Polytechnique Fédérale de Lausanne (EPFL) implantable blood sensor uses bioelectric 'skin' energy



Human body energy

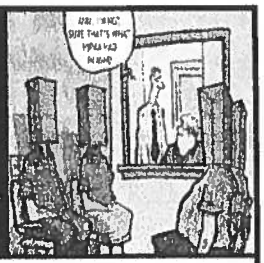
Legal & Ethical Challenges

- Legal, ethical
  - Telemedicine
    - Lack of regulations
      - Which state regulations? Patient's or Physician?
      - Who is responsible for malpractice?
    - Risk of fake physicians
    - Physician out-of-state competition
  - Insurance & reimbursement
  - Patient confidentiality
- Ethics
  - Perfect transparency
  - Who has control over the system
  - Fight laziness with 'enhancing' technology

Privacy

(depends on contextual expectations & purpose)

- Privacy
  - Encrypt data
  - Patient authentication (Owner aware)
- Patient Request for Confidential Communications
- Disposal of Confidential Information
- Authorization to Access Medical Records: Self and Others
- Identity Theft Prevention and Response
- Business Associate Agreements
- Patient Safety and Confidentiality - Alter Security Risk



1.	Names	10.	Account numbers
2.	All geographical identifiers	11.	Certificate/license numbers
3.	Dates (other than year) directly related to an individual	12.	Vehicle identifiers and serial numbers, including license plate numbers
4.	Phone numbers	13.	Device identifiers and serial numbers
5.	Fax numbers	14.	Web Universal Resource Locators (URLs)
6.	Email addresses	15.	Internet Protocol (IP) address numbers
7.	Social Security numbers	16.	Biometric identifiers, including finger, retinal and voice prints
8.	Medical record numbers	17.	Full face photographic images and any comparable images
9.	Health insurance beneficiary numbers	18.	Any other unique identifying number, characteristic or code except the unique code assigned by the investigator to code the data

Security

- Wearable Device can be hacked and attacked wirelessly over Bluetooth/ZigBee networks
- Spoofing, phishing & link altering (forging destination for server, email address…)
- Side channel attacks
  - leak secrets from a virtual machine (VM) located on a CPU to another VM located elsewhere
  - victim into coming to the attacker-controlled website
  - the attacker requests a password reset from victim

Intrusion

- Too much personalization or assistance will repel users
- Users will be overwhelmed by the huge amount of data and can easily be panicked by misinterpreting any vital health data
- Intrusions may curb creativity and reduce recall of relevant activity

Wearable & Mobile Design Issues

- Issues:
  - Physical interference with movement
  - Difficulty in removing and placing
  - Weight
  - Frequency and difficulty of maintenance
    - Charging
    - Cleaning
  - Social and fashion concerns
- Suggestions:
  - Use common devices to avoid stigmatization
  - Lightweight
  - Easy to maintain

User Interface Design Issues

- Simple Interface
- Limit possibility of error
- Avoid cognitive overload
  - Limit options
  - keep dialogs linear
  - Avoid parallel tasks
- Consider all stakeholders
  - Patient, formal onsite/offsite caregivers, informal onsite/offsite caregivers, technical personnel

Assistive Robotics Challenges

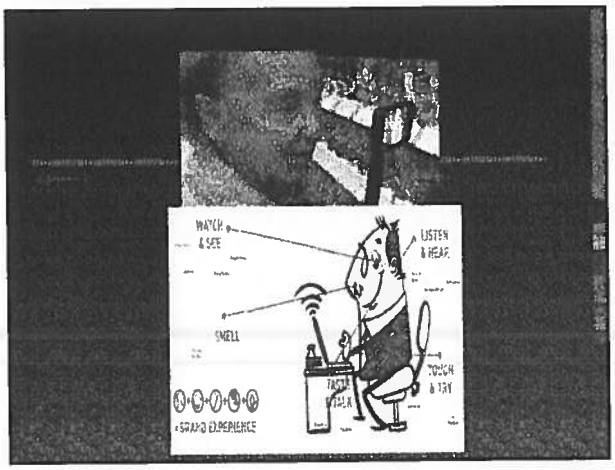
- Assistive robotics
  - Marketing and price
  - Lack of reliable technology
  - A robot fully capable of helping with all Activities of Daily Living (ADLs)
  - Adaptive robots
  - More user studies

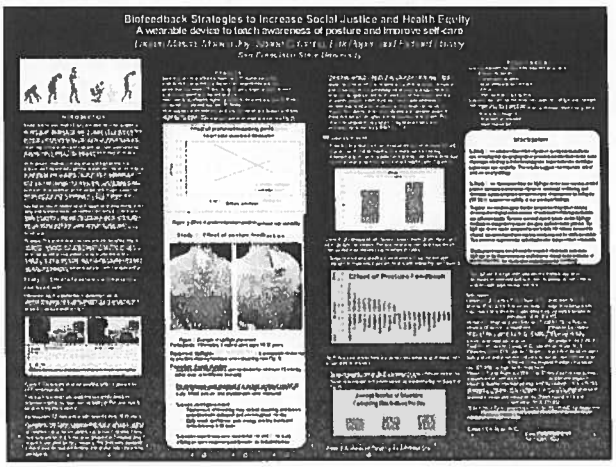
Center for Advanced Studies in Adaptive Systems (CASAS project)

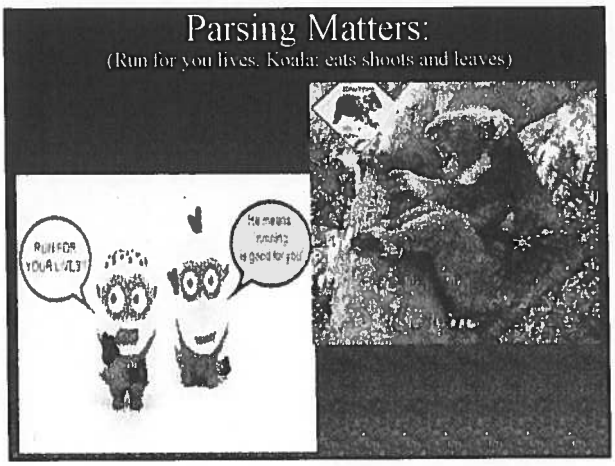
- US =Aging in Place, TigerPlace (U. of Missouri), Aware Home (Georgia Tech), CASAS (Washington State U.), Elite Care (OHSU, OR), House_n (MIT)

Asia =Welfare Techno House, Ubiquitous Home (Japan)

- Europe =iDorm (University of Essex), HIS (France)




Biofeedback Strategies to Increase Social Justice and Health Equity
A wearable device to teach awareness of posture and improve self-care


Parsing Matters:
(Run for you lives. Koala: eats shoots and leaves)
RUN FOR YOUR LIVES!!
He means running is good for you!