Embodied Perspective on Emotion-Cognition Interactions

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Introduction

- There have been new revelations in ways to understand the processing of emotionally significant information
- Perceiving and thinking of such information may involve perceptual, somatovisceral, and motoric reexperiences of the emotion in the self
- This is called embodiment

Representing Emotion: Amodal and Modal Accounts

Traditional 'amodal', symbolic accounts of information processes:

- information initially encoded in perceptual systems and later transformed into a separate conceptual form
- symbols bearing no connection to sensory event enters higher level processes (ex: thought, language)

What does this mean?

- Knowledge of emotion is equivalent to knowledge of other things.

  Anger: thwarted goal, desire to strike out, clenched fists

  equivalent to

  Car: Engine, exhaust pipe, tires

So: emotion is not a topic of unique interest

Representing emotion: Amodal and Modal accounts (cont.)

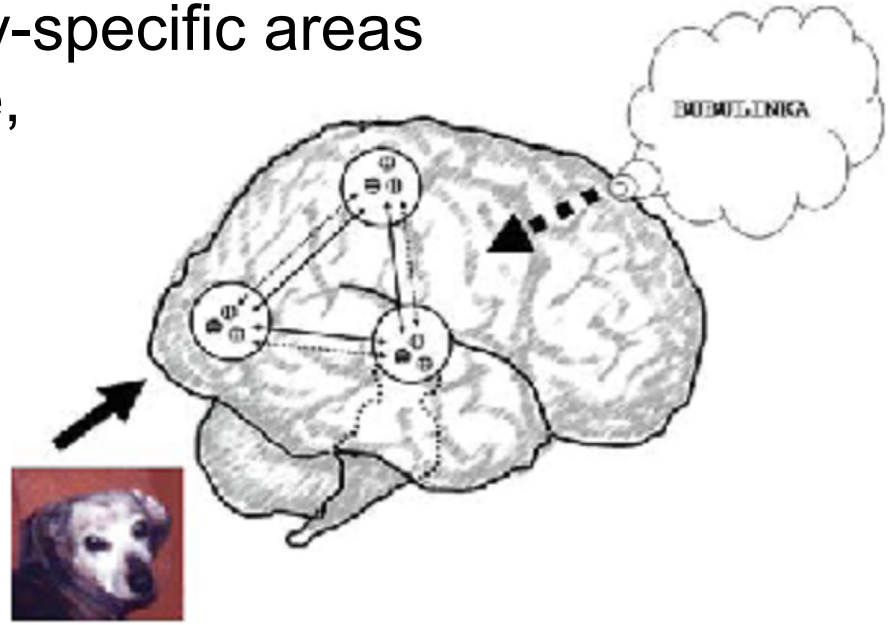
Embodied Cognition Theories:

- High-level cognitive processes are modal
- Knowledge involves partially re-experiencing events

Application to processing of emotional information:

1) Sensory-motor states triggered during encounter with stimulus are stored in modality-specific areas
2) During recovery of experience, original activation is repeated

* Reactivation can be partial, and involves dynamic, online use of modality-specific information.



Representing emotion: Amodal and Modal accounts (cont.)

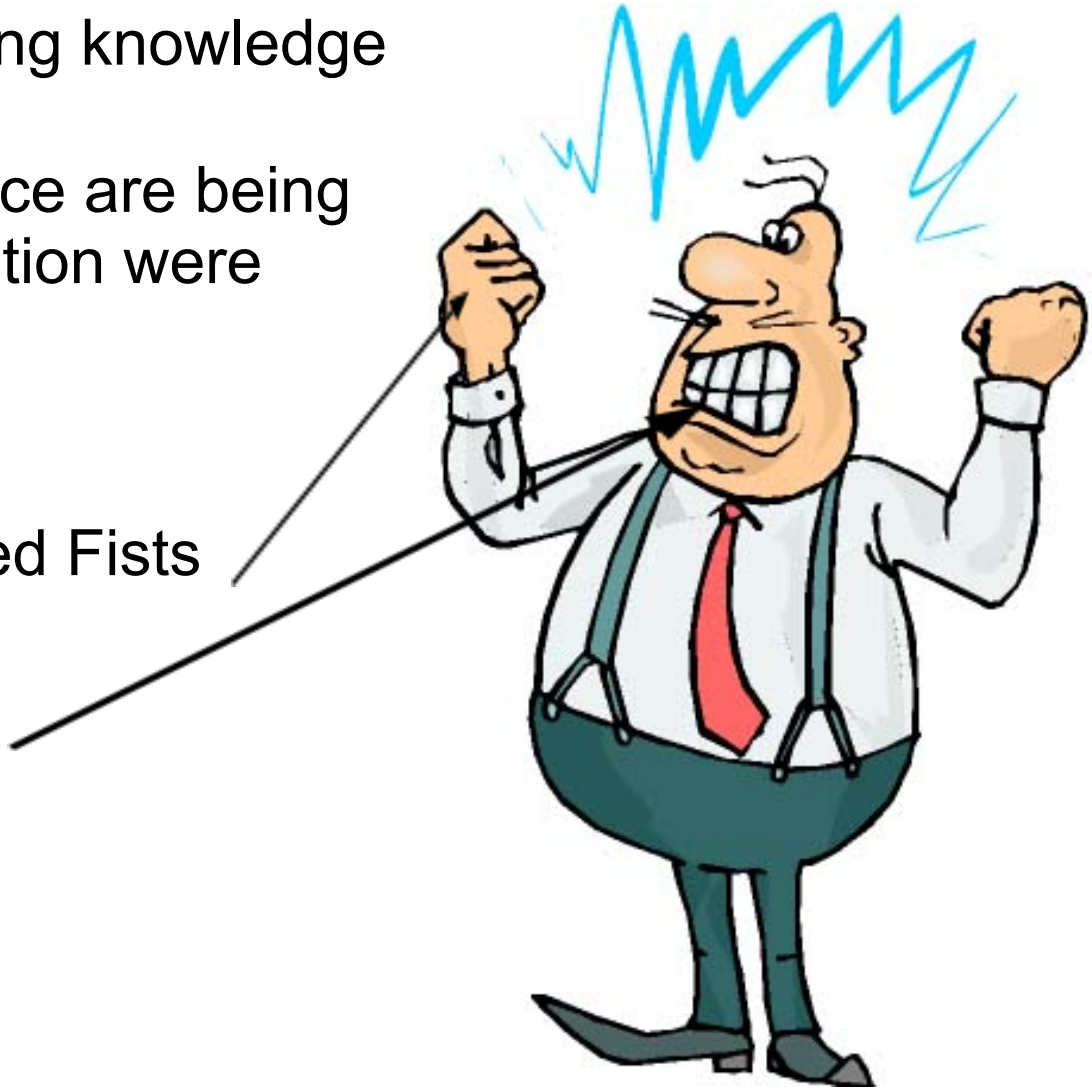
Embodied simulation: using knowledge and making plans

*parts of prior experience are being activated as if the situation were happening again

Ex: ANGER

Clenched Fists

Scowl



Mechanisms of Embodiment and Simulation

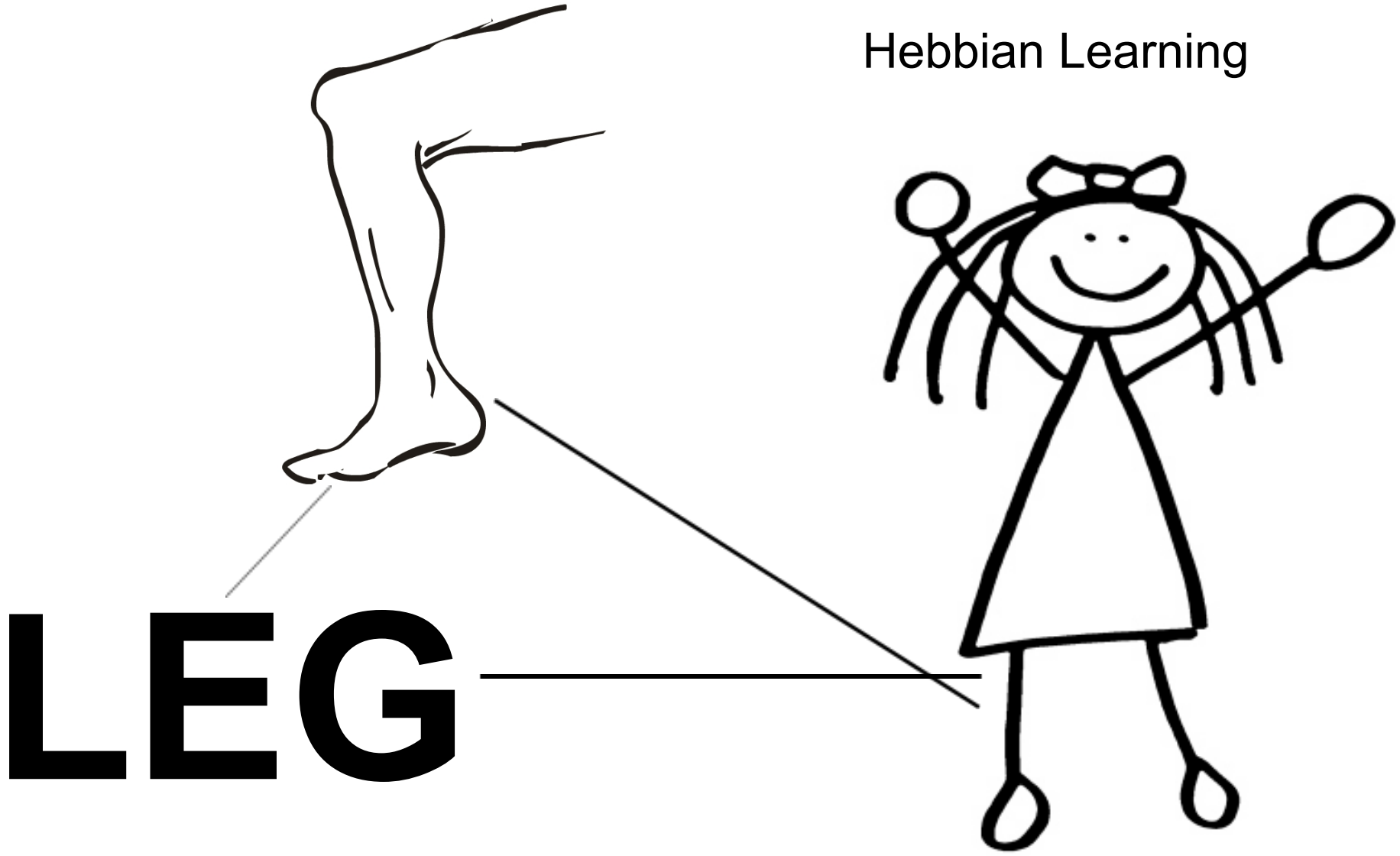
're-experience' 'simulation' and 'mirroring'
Current areas of debate:

1. Relative role of central and peripheral mechanisms:
   - Autonomic feedback contributes to emotional experience.
   - Modern embodiment theories - peripheral input works together with modality-specific systems
2. Exact substrates of "simulation mechanisms":
   - Brain represents information across 'convergence zones', higher areas responsible for more abstract aspects.
   - Preserves modal contents.
   - Allows selective reactivation.
   - No unique 'simulation' system

Mechanisms of Embodiment and Simulation (cont.)

3. Relation between mechanisms of simulation and mirroring:
   - mirroring might be supported by MN, or MN system
   - Disagreement:
     - where are MNs?
     - are MNs actually in a system?
     - are MNs specialized neurons?
   - Research in monkeys found MN in inferior parietal, inferior frontal cortex
   - 'Mirror neuron area' in Broadmann area 44
   - MN in other areas of the brain (insula, anterior cingulate, STS, etc)
     - scattered, or function
   - Neural coding tends to co-localize similar functions

Mechanisms of Embodiment and Simulation



Embodying Emotion

- William James (1884) proposed that bodily changes follow directly the perception of the exciting fact, and that our feeling of the same changes as they occur is the emotion
- Zajonc and Markus (1984): proposed that sensory-motor actions are an intrinsic part of representation of emotional state
  - Merely thinking about emotional content can elicit incipient facial expressions and other physiological markers of emotional processing
  - Just merely observing emotional behavior can elicit covert mimicry
    - Examples: matching facial expression and emotional tone of voice
    - One possible explanation for this is the Stimulus-Response Link

Embodying Emotion (Cont.)

- Others think that associative learning is the key to recognition and understanding of action and emotion (Heyes, 2001)
- Theories of embodied cognition suggest that engagement of sensory-motor processes is part of the process of emotional perception, understanding, learning, and influence.

Perceiving Emotional Information: Peripheral Mechanisms

- Niedenthal, Brauer, Halberstadt, and Innes-Ker (2001) studied the role of feedback from facial muscles.
- They suggested that mimicry (reproducing the observed stimulus using one's own muscles) is casually involved in perception of facial expression of emotion.
- Experiment (2001)
  - Participants asked to identify the point at which a morphed face changed from happy to sad and vice versa
  - Some participants were able to freely move their faces naturally
  - Others were told to hold a pen sideways in their mouths, between teeth and lips
  - This manipulation prevents facial mimicry (must keep pen intact)
  - No mimicry means reduced somatic feedback that supports the detection of change in the observed expression
  - Result: those whose facial movements were blocked by the pen took longer to detect the change in expression in both directions (happy to sad, sad to happy) than those who were able to move their face freely.

Perceiving Emotional Information: Peripheral Mechanisms (Cont.)

- Oberman, Winkielman, and Ramachrandran (2007) extended this research by adding several controls and examining the specificity of the mimicry-blocking effect
- Embodiment account says that recognition of a specific type of facial expression should be impaired when you block mimicry in the group of facial muscles used in the production of that specific type of facial expression.
  - For example, in the first experiment, a person who had to hold a pen in their mouth wouldn't be able to recognize anger or fear because the facial expression already physiologically simulates anger or fear, therefore producing no somatic feedback to stimulate emotion.
  - Two new experiments tested this hypothesis using four expressions and four manipulations of facial mimicry

Perceiving Emotional Information: Peripheral Mechanisms (Cont.)

Four Expressions:

- Happy
- Disgust
- Fear
- Sadness

Four Manipulations:

- Holding a pen sideways between the teeth
- Chewing gum
- Holding the pen just with the lips
- No task

Results:

- Experiment #1
  - Used electromyography (EMG)
  - Found that holding a pen sideways between the teeth selectively activates muscles involved in producing expressions of happiness.
  - The gum manipulation broadly activates several facial muscles but only intermittently
  - The lip manipulation had no effect on EMG

Perceiving Emotional Information: Peripheral Mechanisms (Cont.)

- Experiment #2: tested for accuracy of emotion discrimination
  - Found that pen-biting manipulation selectively impaired recognition of happiness but had no effect on recognition accuracy for disgust, fear, and sad expressions.
  - This suggests that recognition of a specific kind of facial expression involves selective recruitment of muscles used to produce that expression
  - This is exactly what embodiment account predicted

Perceiving Emotional Information: Central Mechanisms

- What are the role of central mechanisms underlying embodied simulation?
- Adolphs et al. (2000) - Experiment
  - 108 total patients with a variety of focal brain lesions
  - 30 normal control participants
  - Told to perform three visual emotion recognition tasks
    - First task: participants rated the intensity of basic emotional facial expressions
    - Second task: participants matched facial expression to its name (identification)
    - Third task: participants sorted facial expressions into emotional categories

Perceiving Emotional Information: Central Mechanisms (Cont.)

- Results:
  - Each task uses a different region of the brain
  - Damage to primary and secondary somatosensory cortices impaired performance on all three task
  - It is consistent with embodiment view that says emotion perception involves simulating the relevant state in the perceiver using somatosensory resources
- Note: This study did not report a particularly critical role of the classic mirror neuron areas (BA 44) in the recognition of facial expressions but such suggestions have been made in fMRI literature.
  - Carr, Iacoboni, Dubeau, Mazziota, and Lenzi (2003) study found that participants who were asked to both observe and imitate emotional facial expressions as opposed to just observing had higher activation in the inferior frontal cortex (MN area), superior temporal cortex, insula, and amygdala.

Perceiving Emotional Information: Central Mechanisms (Cont.)

- There is evidence for selectivity of central mechanisms in embodied simulation of specific emotions
- Wicker, Keyser, Plailly, Royet, Gallese, and Rizzolati (2003) study:
  - Asked participants to inhale odors that generated strong feelings of disgust
  - They were then instructed to watch videos displaying other individuals expressing disgust
  - Result: they had higher activation in the anterior insula and limited activation in the anterior cingulate cortex (ACC) when individuals experienced disgust and when they observed it in others
  - It was presumed that they had simulation for disgust
  - Therefore it is believed that the anterior insula and ACC are responsible for the simulation of disgust in humans and that damage to these brain regions results in a paired impairment in the experience and recognition of disgust

Emotional Understanding and Empathy

- Embodied simulation can shed light on the greater picture of emotional understanding and empathy
- Hutchinson, Davis, Lozano, Tasker, and Dostrovsky study (1999):
  - Found activation of pain-related neurons during own experience of pain AND watching experimenter inflict pain upon himself
- Change in activation in brain areas across participants is related to their level of empathy
  - Activation of pain-related regions upon watching confederate pained, but only if he played fairly in previous economic game (Singer et al, 2004)
- Goal- and context-dependent nature of simulation

Social Functioning: Typical Individuals

- If constructing embodied simulations is critical for emotional understanding, shouldn't it be crucial for social functioning?
- Zajonc, Adelman, Murphy, and Niedenthal (1987) found greater facial symmetry in couples married > 25 years than in the same couples at beginning of marriage
  - Occurs because of tendency to mimic each other to empathize
  - Facial similarity correlated with quality of marriage
- McIntosh (2006) found that observed who were made to like a confederate showed more facial mimicry than those who were not made to like the confederate
  - Reverse was true as well (Chartrand and Bargh, 1999)

Social Functioning: Typical Individuals (cont.)

- What connects mirroring with social relationships?
  - Modification of self-other overlap
- Engaging in mimicry or even simple touch can reduce psychological distance to the mental representation of other, make more personal (Smith and Semin, 2007)
  - Reverse is true as well
- Again, social context is crucial for simulation and mirroring processes

Social Functioning: Individuals with Autism

- Substantial evidence that individuals with ASD have deficits in spontaneous imitation of both emotional and non-emotional stimuli
  - McIntosh et al. (2006) study:
    - ASD and control participants were shown picture of happy and angry facial expressions, while facial movements were recorded by EMG
    - Two conditions: Told to imitate, or just told to watch
    - Both groups showed same level of imitation when told to imitate, but only typical adults spontaneously mimicked, ASD showed no response
- Proposed that these imitative deficits come from impairments in mirror neuron system

Social Functioning: Individuals with Autism (cont.)

What does the evidence say?

- Hadjikhani et al. (2006) found local decreases of gray matter in mirror neuron system areas in ASD individuals
  - Cortical thinning of these areas correlated with severity of ASD symptoms
- Nishitani et al. (2004) study:
  - Asked Asperger's Syndrome and control participants to imitate pictures of women performing facial gestures
    - AS group showed weaker activation in inferior frontal lobe and primary motor cortex, suggesting reduced MN activity
- Oberman et al. study:
  - recorded mu wave suppression in typical and ASD subjects-- an EEG index of activity in primary motor cortex and likely premotor MN area
  - typical individuals showed mu wave suppression to both observation and execution of activity; ASD only during execution

Social Functioning: Individuals with Autism (cont.)

- Consistent with literature on role of self-other overlap, there is evidence that autistic impairment in spontaneous imitation is due to failure to map observed actions onto self
  - Theoret et al. (2005) recorded MEPs from participants' muscles- both typical and ASD subjects
    - Videos of finger movements towards and away from the participants elicited increased MEPs in typical group-- spontaneous mirroring
    - ASD group only showed MEPs to actions towards them but not others-- reduction in self-other mapping?
- fMRI study by Dapretto et al. (2005):
  - Compared to controls, ASD participants showed lower activation in variety of regions, including mirror neuron region, to both observing and imitating actions
  - Negative correlation of activation with severity of ASD symtoms

Influence of Emotion on Complex Behavior

- Exposure to affective primes can elicit somatosensory reactions

→ bias/guide processing of subsequent stimuli

– emotional faces, evocative scenes or valenced words (negative valence or positive valence)

- Stimuli that can trigger embodied response should have greater impact on subsequent behavior than stimuli that are comparable in semantic aspects of valence but do not trigger an embodied response

Influence of Emotion on Complex Behavior (cont.)

- Winkielman and Gogolushko study – compared the impact of emotional faces and scenes vs emotional words on consumption behavior (pouring and drinking of a novel beverage)
- Experiment 1 – emotional facial expression influenced consumption behavior in valance-congruent ways
  - happy primes = more pouring and drinking than angry primes
- Experiment 2 – emotional words had no systematic effects on behavior

Influence of Emotion on Complex Behavior (cont.)

- Knutson and collegues (2008) - study on erotic pictures and gambling
- Ppts shown an erotic picture and then decided b/t making a small or large gamble
  - Preferred large gambles after erotic, rather than control pictures
- Affective influence mediated by the degree to which affective picture was able to activate the excitement and reward-related brain structures (i.e. nucleus accumbens)
- Stimulus must elicit an embodied response in order to influence a complex behavior (consumption of novel drink or a financial choice)

Attitude Formation

- Well's and Petty (1980) – ppts instructed to nod heads vertically or shake heads horizontally while wearing headphones
- Heard either disagreeable or agreeable mssg about a university-related topic
- Earlier head movements moderated judgments
  - RESULTS: those who nodded while hearing the mssg were more favorable than those who had shaken their heads

Attitude Formation (cont.)

- Able to enhance an attitude toward an object by covertly inducing individuals to smile

– ppts asked to rate different novel cartoons while holding a pencil between their front teeth (easier to smile)

– other ppts instructed to hold pencil between their lips w/out touching pencil with their teeth (difficult to smile)

– RESULTS: cartoons were evaluated as higher by individuals with facilitated smiling rather than inhibited smiling

Expression of Attitudes

- Solarz (1960) – asked ppts to move cards with words that were mounted on a movable stage either toward or away from themselves
- Ppts responded faster with the pulling movement (typically associated with approach) to positive than to negative words and faster with the pushing movement (typically associated with avoidance) to negative than to positive words

Flexible Embodiment

- Complex relationship b/t valence and a specific muscle action or a specific direction of movement

- Centerbar and Clore (2006) - study with positively and negatively valenced ideographs and found that the impact of specific muscle movement on later evaluation depended on the initial stimulus valence
  - negative stimuli -- muscle extension (pushing away) led to more postive attitude than muscle flexion (pulling toward)
    - pushing away bad stimulus more compatible action than pulling it toward onself --> action feels more fluent and pleasant

Flexible Embodiment (cont.)

- Wentura, Rothermund, and Bak (2006) - ppts asked to respond to positive and negtaive words by either reaching out their hand to press a button or by withdrawing their hand from the button
  - pressing button = extension movement (approaching it)
  - not pressing a button = flexion movement (avoiding it)
- RESULTS: Ppts pressed button faster for positive than for negative stimuli but withdrew their hand faster for negative than positive stimuli
- positive valence facilitates any motor action (push or pull) that brings the stimulus closer to the self

Flexible Embodiment (cont.)

- Bodily postures and motor behavior associated with positive and negative inclinations and action tendencies toward objects influence acquisition and expression of attitudes toward those objects --> attitude grounded in embodied response
- Link b/t embodied response and valance is flexible and depends on
  - feature of current situation
  - initial value of the stimuli
  - how ppts interpret the meaning of the specific action
- Flexibility consistent with modern theories of embodied cognition -- use of somatosensory and motor response as a constructive on-line process, which dynamically utilizes relevant resources

Linguistically Represented Emotion Knowledge: Emotion Concepts

- Embodied simulation is involved in the representation of abstract emotion knowledge (Niedenthal, et al, under review)
- Participants provided yes/no answers about whether concepts were associated with an emotion
- In the first study, words were associated with concrete objects (ie. PARTY, VOMIT)
- In the second study, words were abstract and referenced emotional states and conditions (ie. DELIGHTED, NAUSEATED)
- EMG results suggested the individuals simulate the relevant, discrete, expressions of emotion on their faces
- It is important to note that the results reflect attention and that the facial muscle activation is not an automatic response

Linguistically Represented Emotion Knowledge: Emotion Concepts

- Switching from one sensory modality to another has temporal processing costs (Spence, et al, 2001)
- It takes longer to locate a visual stimulus after locating an auditory stimulus
- Similarly, individuals take longer to verify that object categories possess certain features if the features are processed in different modalities (Pecher, et al, 2003)
  - ie. Slower to verify a BOMB as LOUD after they have verified a LEMON as TART as opposed to LEAVES as RUSTLING
- Also, verifying a VICTIM as stricken takes longer after verifying SPIDER as black vs ORPHAN as hopeless

Linguistically Represented Emotion Knowledge: Emotional Language

- Comprehension of complex sentences may involve embodied conceptualizations of the situation that language describes (Glenberg & Robinson, 2004; Zwann, 2004)
- Steps in language comprehension
  - Index words/phrases to embodied states that refers to the objects
  - Observer simulates possible interactions with objects
  - Message is finally understood when a set of actions is created
- So, if the comprehension of emotionally meaningful sentences requires reenactment of emotional bodily states, then the simulation of congruent/incongruent emotions should facilitate/inhibit language comprehension

Linguistically Represented Emotion Knowledge: Emotional Language

- Havas, Glenberg, & Rinck, 2007
- Participants judged whether a sentence described a pleasant or unpleasant event
  - while holding a pen between teeth (induce smiling)
  - holding a pen between the lips (induce frowning)
- Participants were faster at determining a pleasant sentence when they were "smiling"
- Participants were faster at determining an unpleasant sentence when they were "frowning"

Open Issues

- Many studies show that embodiment is causal (not just correlational) when processing emotional information
- Theoretical challenge
  - Representation and processing of abstract information
  - How do people understand social concepts, legal concepts, or logical concepts?
  - How do people understand the differences between shame, embarassment, and guilt?
- Difficulty clarifying the differences between emotion and non-emotion concepts