Bi/CNS/NB 150: Neuroscience

Lecture

Monday, Nov. 23, 2015
Ralph Adolphs

Emotion
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| Emotion | **Emotion and Social Behavior**
Emotions are functional states implemented in the brain
Emotion states cause feelings, behavior, psychophysiology
Emotions also cause changes in cognition (attention, memory)
Specific brain structures participate in processing emotions
The amygdala is important for fear |
| Ch. 64: p. 1425-1434 | Nov. 25 |
| Autism | **Autism**
Autism is a spectrum with an unscientific diagnosis
Autism involves atypical social cognition
Autism involves many genes that influence brain connectivity
There are animal models for autism |
| review for final | Nov. 27 |
| Thanksgiving | **eat Turkey** |
Emotion theories
ANS
fear & disgust
Emotion structures
hypothalamus
OFC
Amygdala
What is an emotion?

Not cognition
Dual Process Theories

System 1:
   --automatic
   --emotional
   --rapid

System 2:
   --effortful/ controlled
   --rational
   --slow
Some Emotions

• Basic Emotions: happiness, surprise, fear, anger, disgust, sadness

• Social/Moral Emotions: guilt, shame, pride, embarrassment, jealousy
Emotions are important!

We (nearly) always feel some emotion

Emotions are what matters most about our experience
randomly assigned to answer a happiness question from 2250 adults (58.8% male, 73.9% residing in the United States, mean age of 34 years) who were from 86 major occupations. The application contacts participants through their iPhones, which we used to create an unusually large database of real-time reports (Cupertino, California), which we used to create an application for the iPhone (Apple Incorporated, 2010). Mind wandering and happiness and has always been limited to very small samples (minds wandered and had almost no impact on the happiness, but mind wandering explained 4.6% of the within-person variance in happiness). The nature of people as they go about their daily lives is so cumbersome that experience sampling has rarely been able to resist mind wandering and has always been limited to very small samples (minds wandered and had almost no impact on the happiness, but mind wandering explained 4.6% of the within-person variance in happiness). The frequency of mind wandering (12% of the samples taken during every activity occurred in 46.9% of the samples and in at least 30% of the samples taken during every activity). Multilevel regression revealed that people were no happier when thinking about pleasant topics (b = 0.52, not significant) and were considerably unhappier when thinking about neutral topics (b = -7.2, p < 0.001) or to think about anything (b = -12, p < 0.001). Time-lag analyses (306, 315, 393, 2007) of between-person variance in happiness. The variance of within-person variance in happiness and 17.7% explained 30.7% of the variance in happiness, but mind wandering explained 10.8% of the variance in happiness. The variance of within-person variance in happiness and 17.7% explained 30.7% of the variance in happiness, but mind wandering explained 10.8% of the variance in happiness. The variance of within-person variance in happiness and 17.7% explained 30.7% of the variance in happiness, but mind wandering explained 10.8% of the variance in happiness.
There is also a big field of study of how we INFER what emotions people are having.

Social perception --> attributions --> social behavior
WHEN YOU'VE BEEN MARRIED A LONG TIME, YOU GET TO KNOW WHAT THE OTHER PERSON THINKS.

NO YOU DON'T.
Process Theories of Emotion
Motor output at different levels

Reflexes
  --spinal
  --central

"Fixed action patterns"

Emotional reactions

Actions

Long-term plans

Stimulus-coupled

Stimulus decoupled
Some characteristics of an emotion

1. Phasic (vs. moods)
2. Has onset, duration, decay
3. In humans, often regulated
4. Can be broken down into some components

Stimulus → Evaluation → Emotional Response

Context → Expectation → Individual Differences
Figure 1
Some of the emotions associated with different reinforcement contingencies are indicated. Intensity increases away from the centre of the diagram, on a continuous scale. The classification scheme created by the different reinforcement contingencies consists of (a) the presentation of a positive reinforcer (S+), (b) the presentation of a negative reinforcer (S−), (c) the omission of a positive reinforcer (S+) or the termination of a positive reinforcer (S+!), and (d) the omission of a negative reinforcer (S−) or the termination of a negative reinforcer (S−!).
William James (1882): "What is an emotion?"

--perception of our emotional response

--pattern of bodily response discriminates emotions

“If we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of its characteristic bodily symptoms, we find we have nothing left behind, no “mind-stuff” out of which emotion can be constituted, and that a cold and neutral state of intellectual perception is all that remains.”
Psychophysiology

Galvanic Skin Conductance (GSR, SCR)

Electrocardiogram (EKG)

Facial Electromyogram (facial EMG)

Pupillometry, Respiration, Skin temperature, blood pressure
(b) Pupillary constriction

Parasympathetic stimulation of circular muscle

(c) Pupillary dilation

Sympathetic stimulation of radial muscle

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Charles Darwin (1872)
"The Expression of the Emotions in Man and Animals"

--3 principles:
serviceable associated habits
antithesis
direct action of nervous system

--idea of “basic” emotions
Fig. 7.—Half-breed Shepherd Dog in the same state as in Fig. 3. By Mr. A. May.
Rethinking the Emotional Brain

Joseph LeDoux1,2,*
1Center for Neural Science and Department of Psychology, New York University, New York, NY 10003 USA
2Emotional Brain Institute, New York University and Nathan Kline Institute, Orangeburg, NY 10962 USA
*Correspondence: jel1@nyu.edu
DOI 10.1016/j.neuron.2012.02.004

- Do not use “emotion” scientifically
Why?

1. Because most people confuse “emotion” with “feelings”
2. And we cannot tell if animals have feelings
1. Emotions are Internal/Central Functional States
2. Emotions are caused by particular stimuli/contexts
3. Emotions CAUSE behavior
4. Emotions CAUSE feelings

5. Emotions have characteristic features
stimuli → central emotional state

- observed behavior
- subjective reports
- psychophysiology
- cognitive changes
- somatic responses

context → volitional control
1. Scalability (intensity)  
2. Valence (antithesis)  
3. Persistence  
4. Context and Stimulus Generalization  
5. Pleiotropy  
6. Priority over Behavioral Control  
7. Poised for Social communication  

Similarity structure (2-D)  
Flexibility  
Automaticity
1. Scalability (intensity)
2. Valence (antithesis)
3. Persistence
4. Context and Stimulus Generalization
5. Pleiotropy
6. Priority over Behavioral Control
7. Poised for Social communication

Similarity structure (2-D)

Flexibility

Automaticity

Uniquely Human Aspects?

8. Control
9. Subjective Report
10. Stimulus Decoupling
Modules for recognizing emotions from faces

- Fear: amygdala
- Disgust: basal ganglia (HD), insula
Figure 1

Disgust

Fear
Disgust

- Lowered brow
- Narrowed eyes
- Narrowed nostrils
- Closed mouth

Fear

- Raised brow
- Widened eyes
- Flared nostrils
- Open mouth
However, the lower visual field under neutral viewing conditions more strongly test of sensory vigilance is to show that peripheral stimulus detection is altered by expression. To corroborate the subjective results, the functional importance of fear expressions may be argued as having limited functional importance.

Disgust expressions relative to neutral. Relative velocities were scaled at each time point by the ratio of instantaneous-to-peak neutral velocity. Relative velocities were scaled at each time point by the ratio of instantaneous-to-peak neutral velocity. Relative velocities were scaled at each time point by the ratio of instantaneous-to-peak neutral velocity. Relative velocities were scaled at each time point by the ratio of instantaneous-to-peak neutral velocity. Relative velocities were scaled at each time point by the ratio of instantaneous-to-peak neutral velocity.

Disgust resulted in changes in physical differences in eye aperture compared to neutral, with the effect of expression depending on visual-field location. (not for the horizontal meridian (condition for the upper visual field (participants detected objects at farther eccentricities than in the neutral baseline. Unit markings are in 9.5° increments from film clips taken during the directed facial action task (see Methods). Stimulus trials in which no stimulus was present did not reveal any differences in eye size compared to neutral.

Figure 3a shows the visual-field location. (Changes in visual field estimation along horizontal, vertical and oblique axes. Central ellipse is 1°, and Figs. 2b, 3b, 4b show the changes in visual field size by correlating it with visual-field changes along the vertical meridian (relative to disgust (predicted, fear expressions resulted in greater vertical eye opening (than expected, but not for the horizontal meridian (condition for the upper visual field. (Participants detected objects at farther eccentricities than in the neutral baseline. Figure 3d shows the correlation of vertical eye-size measurements of participants with perceived changes in the upper visual field (o

Figure 4 shows the eye velocity minus neutral (vs. Peak velocity (deg s−1) for disgust (Fear). Employing the directed facial-action task, participants were prompted to pose a facial expression for 5 s while carrying out saccades (ods). We measured participants’ eye movements during horizontal saccades to examine the effects of expression. We found that after equating for saccade distance, the above results demonstrate that fear expressions are associated with increased eye-scanning speed relative to neutral expressions and pronounced slowing relative to disgust expressions relative to neutral. Relative velocities were scaled at each time point by the ratio of instantaneous-to-peak neutral velocity. Relative velocities were scaled at each time point by the ratio of instantaneous-to-peak neutral velocity. Relative velocities were scaled at each time point by the ratio of instantaneous-to-peak neutral velocity. Relative velocities were scaled at each time point by the ratio of instantaneous-to-peak neutral velocity.

Fear's enhancement only for the upper visual field (a

Susskind et al., Nat Neurosci 2008
Effects of fear and disgust expressions on internal nasal anatomy. (Figure 6)

(a) Axial slices from T1-weighted FSPGR MRI during fear (Fig. 5a) and disgust (Fig. 5b) expressions relative to neutral. Each slice was 1.2-mm thick with an in-plane resolution of 0.86 mm. (Fig. 5c, d) Bar graphs represent average overall air cavity volume for fear and disgust expressions relative to neutral. Air cavity volume equals 1.

(b) Mean air-flow velocity (in standardized units) for fear and disgust expressions relative to neutral during inhalation over time (2.2-s breathing cycle, 2.2 s in/out per breath). Expression configuration had a significant effect on air intake (F(2, 18) = 23.57, P < 0.0001), with fear expressions being associated with a greater increase in air velocity and volume corrected for respiratory effort (P < 0.0001), showing a linear effect of expression (P < 0.0001) relative to neutral expressions (Fig. 5a).

Despite equal duration of inspiration, fear was associated with an increase in air velocity and volume corrected for respiratory effort (Fig. 5a; P < 0.0001) and mean volume relative to abdominal-thoracic respiratory measures acquired during a controlled instructed respiratory cycle (2.2 s in/out per breath). Expression configuration had a significant effect on air intake (P < 0.0001), with fear expressions being associated with a greater increase in air velocity and volume corrected for respiratory effort (P < 0.0001), showing a linear effect of expression (P < 0.0001) relative to neutral expressions (Fig. 5a).

In this study, we examined whether expression appearance may also relate to more primitive chemosensory functions. Disgust has been proposed to originate in defensive reactions related to the rejection of noxious forms of sensory intake, nasal inspiratory capacity36 (see Methods). Altered air intake may reflect a variety of factors rather than genuine changes in sensory capacity afforded by facial expression. We next sought to determine whether visible surface deformations of the face (that is, facial expression appearance) are associated with visible underlying structural changes of the internal anatomy of the nasal passages. In an additional control study, we examined directly whether fear and disgust altered the structure of the nasal passages in terms of the face by examining whether expression appearance may also relate to visible structural changes in sensory capacity afforded by facial expression. Despite equal duration of inspiration, fear was associated with an increase in air velocity and volume corrected for respiratory effort (P < 0.0001) and mean volume relative to abdominal-thoracic respiratory measures acquired during a controlled instructed respiratory cycle (2.2 s in/out per breath). Expression configuration had a significant effect on air intake (P < 0.0001), with fear expressions being associated with a greater increase in air velocity and volume corrected for respiratory effort (P < 0.0001), showing a linear effect of expression (P < 0.0001) relative to neutral expressions (Fig. 5a).

Facial expression was manipulated via the directed facial-action task, which further examines inspiratory-related temperature changes under the condition of the face, including the nose. Despite equal duration of inspiration, fear was associated with an increase in air velocity and volume corrected for respiratory effort (P < 0.0001) and mean volume relative to abdominal-thoracic respiratory measures acquired during a controlled instructed respiratory cycle (2.2 s in/out per breath). Expression configuration had a significant effect on air intake (P < 0.0001), with fear expressions being associated with a greater increase in air velocity and volume corrected for respiratory effort (P < 0.0001), showing a linear effect of expression (P < 0.0001) relative to neutral expressions (Fig. 5a).

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Sensory Cortices → Amygdala OFC → Hypothalamus PAG → Insula Cingulate

Emotion Perception → Association Induction → Emotional Response → Feeling Awareness
Walter Hess

A key aggression relay in the mouse

Lin et al., Nature (2011)

“sham rage”
Putative functions of some brain structures

Amygdala:
--fear, arousal, saliency

Insula:
--disgust, empathy, pain

OFC:
--valence, decisions, social emotions, moral judgment

Cingulate cortex:
--pain, motivation ("akinetiс mutism")
Orbitofrontal Cortex

- emotional and social behavior
- represents reward value of stimuli
- involved in complex decision-making
The equilibrium or balance, so to speak, between his (Gage’s) intellectual faculties and animal propensities seems to have been destroyed. He is fitful, irreverent, indulging at times in the grossest profanity … impatient of restraint or advice when it conflicts with his desires.

John Harlow, 1868
Amygdala
1. The Amygdala’s role in implicit emotional memory (like fear conditioning) is doubly dissociable with the role of the hippocampus in declarative memory.

2. The amygdala is important for learning the value of stimuli, and for regulating social behavior, especially for fear or withdrawal-related behaviors.

3. The amygdala modulates much other cognition.

4. The amygdala shows individual differences and contributes to psychiatric illnesses such as mood disorders.
Heinrich Kluver

“Kluver-Bucy Syndrome”
--tameness
--oral tendencies
--hypersexual
--hypermetamorphosis
--psychic blindness
--altered taste preferences
Amygdala Lesions in Rats
Part 1:
Hungry rat forages for food
Part 3:

Amygdala-lesioned rat meets "Robogator"
The brain of patient S.M.
Measuring the Experience of Fear

1. Standardized Questionnaires
2. Express fear to instruction
3. Fear to films
4. Fear in real life: autobiographical
5. Fear in real life: pet store

Feinstein et al., Current Biology (2011)
Experience sampling with PDA

--3 months
--624 samples
--0 reports of afraid/scared/frightened

Emotional films

--no endorsement of fear

Autobiography

--no fear since age 10
Summary

Emotions are a ubiquitous and salient aspect of our conscious experience.

Fear has been mechanistically dissected in great neurobiological detail, and is an excellent model system.

The amygdala is necessary not only for fear behaviors in rodents, but also for fear experience in humans.

Fear is not in the amygdala, but generated by all the multiple processes orchestrated by the amygdala.