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Section Editors

Functional Anatomy of Humor: Positive Affect and Chronic Mental Illness

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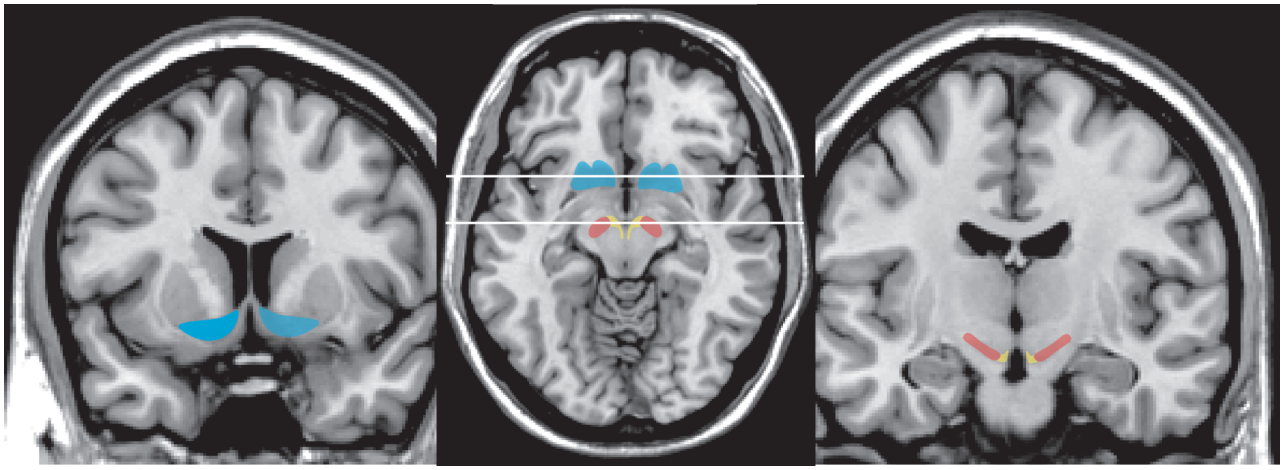
COVER AND FIGURE 1. The dopamine system is a critical component of the brain reward circuitry, important for both motivation and reward-associated functions. The majority of dopamine-containing neurons reside in two midbrain nuclei, the substantia nigra (pink) and the ventral tegmental area (yellow). The dorsal striatum (caudate and putamen) is the major target for the substantia nigra. The ventral striatum (blue, mostly occupied by nucleus accumbens) is a major target for the ventral tegmental area.



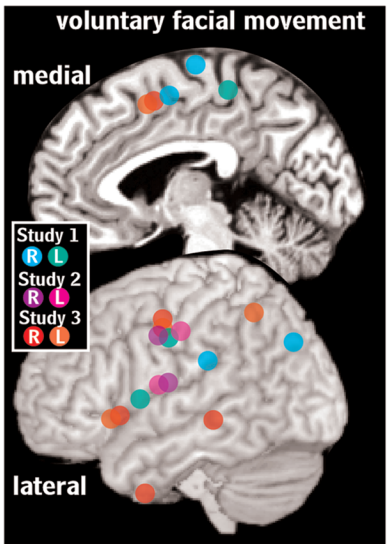


FIGURE 2. Functional imaging agrees with clinical evidence that the neuroanatomical networks supporting voluntary and humor-evoked smiling are different. Motor-related areas (e.g. primary motor cortex, premotor cortex, operculum) are consistently activated during voluntary facial movement (left), but not during humor-evoked smiling (right). Differences in the areas activated probably relate to the different contrasts utilized in these three studies.[1–3]

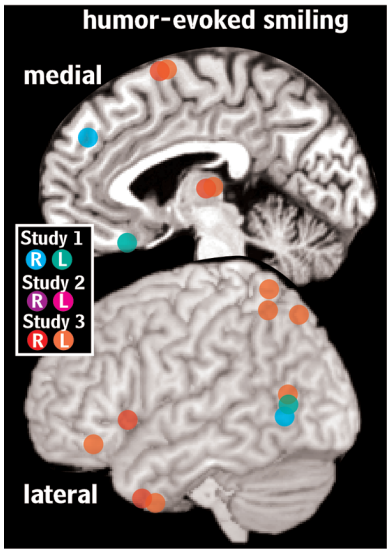
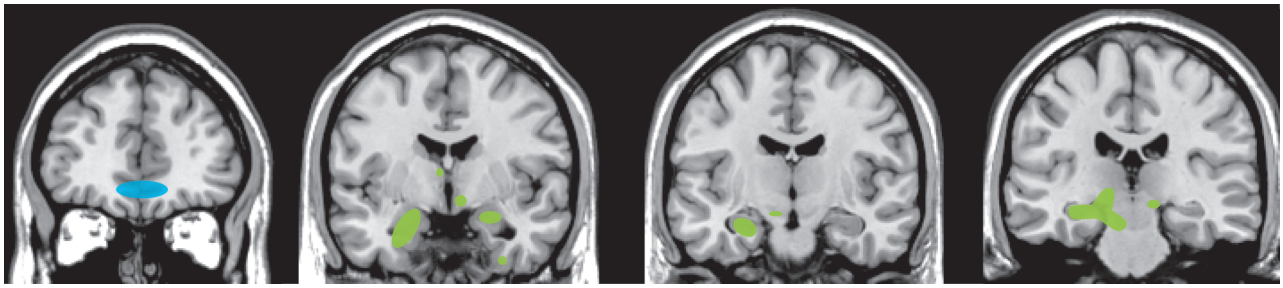


FIGURE 3. One approach to identifying areas of brain important for later stages of humor processing is to look for areas of activation in common between two different types of humor (conjunction analysis).[4,5] A study comparing verbally-presented puns and semantic jokes reported that only an area in medial prefrontal cortex (blue) survived the two step analysis procedure. A study comparing visually-presented captioned and uncaptioned cartoons reported multiple regions of activation in common (green).



While negative emotional states have been extensively studied, investigation of positive emotions is relatively new.[6] An evolutionary perspective on the value of emotions is potentially illuminating. The adaptive value of many negative emotions has been related to promoting fast and appropriate responding during high risk situations (fight or flight).[7] Under life-threatening circumstances, a narrowing of response patterns is necessary for rapid response selection and performance. In contrast it has been proposed that the adaptive value of humor and positive affect is to promote a broadening of response. This provides a way to explore new possibilities in times of safety.[7] In Fredrickson's model, general categories of positive emotions have different but complementary adaptive value that build an individual's physical, intellectual and social resources. The emotion of joy (or happiness), for example, is associated with imaginative play, which is characterized by "exploration, invention, and just plain fooling around."[7] Among other benefits, play promotes the learning of new skills. The emotion of interest (or wonder) promotes exploration, leading to a broadening and deepening of knowledge.

The adaptive value of positive emotions is supported by their evolutionarily early origins. Both spontaneous smiling and laughing have been documented in nonhuman primate species, most commonly as part of social play.[8–10] Gervais and Wilson proposed "nonserious social incongruity" as the common factor for the stimuli that elicit spontaneous laughter, which include safe surprise (infants), tickling and physical play (apes, human children), and incongruity-based humor (human adults, signing apes).[10] The authors note that laughter is both a behavioral response and a signal. In their formulation, laughter and humor benefit both the sender and receiver by spreading positive emotions that promote stability, decrease negativity, moderate stress, and strengthen group identity and cohesion.

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Positive emotions presumably activate areas of the brain involved in reward.[11] The dopamine system is a critical component of the brain reward circuitry, important for motivation, affect and reward-associated functions (Figure 1).[12–16] The majority of dopamine-containing neurons reside in two midbrain nuclei, the substantia nigra and the ventral tegmental area (VTA). The dorsal striatum (caudate and putamen) is the major target for the substantia nigra (nigro-striatal projection). The ventral striatum (nucleus accumbens) is a major target for the VTA. The VTA projects to multiple areas of both the cerebral cortex (mesocortical projections) and limbic system (mesolimbic projections).

It is important to distinguish true humor-evoked laughter and smiling (Duchenne), which are spontaneous emotionally positive responses, from laughter and smiling that are intentionally generated (non Duchenne).[8,10] The neurological pathways involved are clearly different, as indicated by lesion-induced paresis of voluntary facial expression with preservation of emotionally evoked facial expression and vice versa (double-dissociation).[8] Volitional facial paresis has been associated with lesions in primary motor cortex, premotor areas (including the frontal operculum), and/or along the course of the corticobulbar motor tracts. Emotional paresis has been reported in patients with Parkinson's disease, and has been associated with lesions in the thalamus and striatal structures as well as in the pons (i.e., vicinity of the facial nucleus, CN VII). Recent functional imaging studies have further delineated the cortical areas involved (Figure 2).[1–3] Activations (as measured by either positron emission tomography [PET] or functional MRI [fMRI]) were found within primary motor cortex, supplementary motor cortex, and the frontal operculum during voluntary smiling. Primary motor areas were not activated by humor-induced smiling.

Humor is a complex construct, with several stages of processing. Although multiple theories of humor exist, the most accepted is the Incongruity Theory postulated by Sols.[8,17] He proposed that humor occurs in two stages. The first involves the listener's expectation of the joke being disconfirmed by the end; the listener encounters an incongruity (i.e., the punch-line). In the second stage the listener engages in a form of problem solving to resolve the incongruity between the punch-line and the expectation shaped by the joke. This has also been described as "surprise" and "coherence," a similar formulation to that of "nonserious social incongruity" (see above). A third stage has been proposed: detecting that

what actually makes sense is pleasant nonsense (appreciation).[8]

Functional imaging provides a way to identify areas of brain involved in different types of humor and stages of processing. A common approach has been to look for areas in which activation correlates with a measure of amusement intensity (funniness).[1–5,18,19] Results can be complex to interpret. Such activations may be due multiple processes including solving the incongruity in order to understand the joke and appreciation of the humor. Results may also be influenced by how the degree of funniness is determined. For example, a study that used the intensity of smiling (as measured by electromyography) found activity correlated with smiling only in medial prefrontal cortex (BA 6) and putamen, both motor-related areas.[1] Studies that have used subject ratings of funniness, on the other hand, have generally found much more widespread activations.

Two studies have used conjunction analysis in order to identify areas of common activation between two types of humor (Figure 3).[4,5] One study reported a single area (medial prefrontal cortex, BA 10/11) survived the two step analysis procedure when comparing two types of verbally presented humor (puns and semantic jokes).[4] The other study compared two types of visually presented humor (captioned and uncaptioned cartoons).[5] Multiple regions of activation were found, including posterior temporal cortex, inferior frontal cortex, hippocampus and parahippocampal cortex, amygdala, nucleus accumbens and midbrain.

Given the adaptive value of humor in promoting positive emotions, the brain areas activated during the final stage (appreciation) are of particular interest.[20] One intriguing study has used event-related fMRI during presentation of humorous films (with and without a laugh track) to compare the areas activated just prior to laughter (humor detection) to those active during laughter (humor appreciation).[21] Humor detection was associated with activation in the inferior frontal and posterior temporal cortices for both types of film. Humor appreciation was associated with activation in the insular cortex and amygdala. These results are consistent with previous studies, and support the importance of the posterior temporal and inferior frontal regions in resolving the incongruity. The authors of the study also noted that activation of insular cortex and amygdala is consistent with the visceral and emotional aspects of humor appreciation. The involvement of the amygdala may also relate to its role in memory formation, as humorous material is more easily remembered than material that is not.

Although the beneficial effects of humor and laughter have been part of "common wisdom" for many centuries, there is comparatively little solid scientific research in this potentially quite important area.[22,23] As noted above, humor is a complex construct. In research studies humor has been defined in many ways including a stimulus (e.g., viewing a cartoon or humorous film), a response (e.g., laughter), a personality trait (e.g., positive affect), a cognitive process (e.g., resolving the contradiction to understand a joke) and a therapeutic intervention (e.g., humor therapy). The time frame examined has varied from a few minutes to years, depending upon the aspect of humor under investigation. The group sizes range from fewer than 10 individuals to cohorts numbering in the thousands.

Studies that focus on the physiological effects of laughter suggest positive effects on many aspects including immunity and pain tolerance, although some have been criticized on methodological grounds.[22] A more recent review using the broader definition of positive affect (e.g., feelings that reflect a level of pleasurable engagement with the environment) evaluated studies of physical health.[23] The authors differentiated studies of trait positive affect (a stable disposition) and state positive affect (short-term bout), noting that the former would be more likely to influence chronic disease processes, while the latter would be more likely to influence occurrence of sudden events. They found that both prospective and cross-sectional studies support an association between trait positive affect and better health, with lower morbidity in a wide range of conditions (e.g., stroke, accident, common cold). This did not hold for all diseases, particularly those with a high short-term mortality rate (e.g., melanoma). Laboratory studies utilizing induction of state positive affect demonstrated generally positive results (e.g., decreased pain sensitivity/increased pain tolerance, improved immune response). Laboratory studies of the effect on stress responses (as indicated by cortisol level) were less consistent in showing a positive effect. The authors of this review emphasized that there are multiple ways in which positive affect might influence health, some direct (e.g., changes in health practices) and some indirect (e.g., susceptibility to disease, sensitivity to stress).

Humor has been integrated into the practice of medicine in multiple ways.[24–26] Perhaps the most common use of humor is to decrease the sense of isolation that is

often felt by patients, families, and health care workers. Appropriate use of humor can promote communication and strengthen relationships. Humor must be used with care, however, as poorly timed or ill-chosen humor can be detrimental. Clowns have been used in medicine for about two decades. A recent study compared anxiety levels between children accompanied only by parents and children accompanied by both parents and clowns during the preoperative period prior to minor surgery.[27] The presence of clowns was associated with significantly lower preoperative anxiety, supporting a therapeutic benefit. Interestingly, surveys completed by the medical staff indicated both perception of the benefit to the child and widespread opposition to continuing the program.

Two recent studies have explored the effect of very different humor-centered activities on the behavior of hospitalized psychiatric patients.[28,29] In one, twice-weekly clown-lead sessions were provided on an acute psychiatric ward.[28] Sessions were varied, and included games, psychomotor expression exercises and activities based on imaginary situations. Disruptive behaviors during the intervention period were compared to the same period of time (83 days) prior to the intervention. Although there were more patients admitted during intervention period, (101 versus 83) disruptive behaviors decreased in both absolute and relative terms. Of particular interest, the most significantly reduced behaviors were attempted elopements, self-injury and fighting. This change is not likely to be due to differences in the patient populations, as the distribution by diagnosis was quite similar during the two time periods. The authors of the study note that most of the treatment planning in psychiatry is directed toward psychotherapeutic and pharmacotherapeutic inteventions. There has been relatively little focus on the therapeutic milieu. In the second study, movies were provided on two chronic psychiatric wards 5 days per week for 3 months.[29] One group viewed only humorous films. The other group viewed a mixture of film types, with only 15% being humorous. The patients were primarily diagnosed with chronic schizophrenia. A significant reduction in clinically rated negative symptoms, anxiety, and depression was found only in the group that viewed humorous movies. In addition, self-reported anger was decreased and social competence was improved. No changes were found in positive symptoms, activities of daily living, treatment insight, or therapeutic alliance. The authors of the study noted that humorous movies appeared to generate active social exchanges not seen following the non-humorous (e.g., action adventure) movies. Although these studies must be considered preliminary, they both suggest that humor-based interventions can be quite beneficial to patients with chronic mental illness.

Recently, there has been an increasing emphasis on recovery-oriented care in the treatment of chronic mental illness. A review of research in this area identified multiple mechanisms by which pleasure, play and positive life events help to develop and strengthen a patient's ability to take an active role in promoting recovery.[30] These insights support the need for further study of the functional anatomy of positive emotions.

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