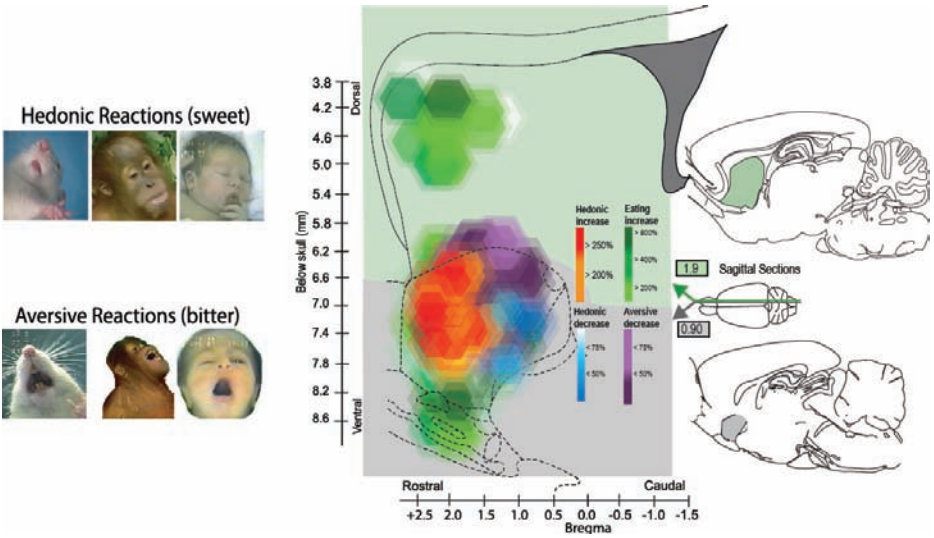

FIGURE 6.1. Hedonic reactions for studying hedonic and motivational hotspots. On the left are shown the positive and negative hedonic reactions to taste found in humans and other animals. On the right are shown details of the hedonic hotspot for pleasure generation in the nucleus accumbens (sagittal view of medial shell and of neostriatum). This is a causation map: colors reflect hedonic or motivation consequences (on "liking" reactions or on food intake) of mu opioid agonist microinjections at each site. Red/orange symbols in the rostrodorsal hotspot show sites that caused doubling or higher levels of hedonic "liking" reactions to sucrose taste. By comparison, at caudal sites the same opioid microinjections only suppressed aversive "disgust" reactions to bitter quinine (purple; e.g., suppressed gapes) or bivalently suppressed both "liking" and "disgust" reactions (blue). Green sites denote increases in motivation "wanting" to eat without any hedonic change in either "liking" or disgust (enhanced motivation also extended through all red/purple/blue sites in the nucleus accumbens). Adapted from Richard, Castro, Difeliceantonio, Robinson, and Berridge (2013) and based on data from Peciña and Berridge (2005). Copyright 2013 by Morten L. Kringelbach and Kent C. Berridge. Adapted by permission.

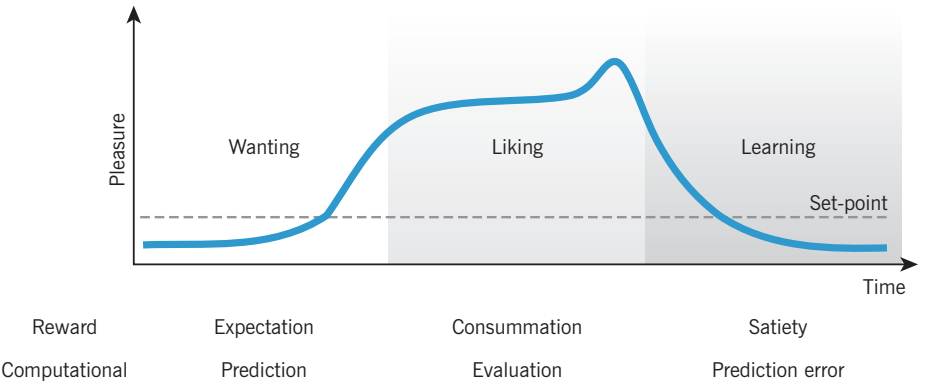

FIGURE 6.2. Pleasure cycles. The brain needs to optimize resource allocation for survival, and individuals are limited in the number of concurrent behaviors they can engage in. Survival depends on engagement with rewards and typically follows a cyclical time course common to many everyday moments of positive affect. Within this pleasure cycle rewards act as motivational magnets to initiate, sustain, and switch states. Typically, rewarding moments go through a phase of expectation or wanting for a reward, which sometimes leads to a phase of consummation or liking of the reward, which can have a peak level of pleasure (e.g., encountering a loved one, a tasty meal, sexual orgasm, a drug rush, winning a gambling bet). This can be followed by a satiety or learning phase, where one learns and updates predictions for the reward.

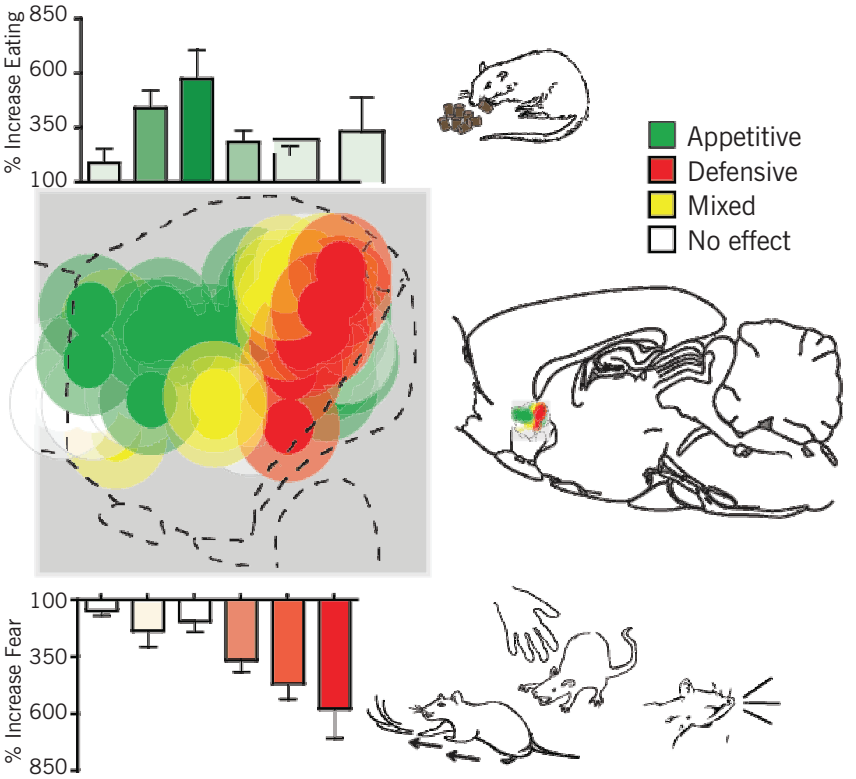

FIGURE 6.3. Affective keyboard for intense desire and dread in the nucleus accumbens. The keyboard pattern of intense motivated behaviors is revealed in the consequences of drug microinjections at various rostrocaudal sites in the medial shell. Microinjections of drugs that relatively inhibit accumbens neurons via amino acid neurotransmitters (e.g., a GABA agonist or a glutamate antagonist) may in turn disinhibit or release motivation-generating circuits in downstream target structures. Rostral green sites released stimulation of eating by up to 600% (desire only). Caudal red sites released purely increased fearful reactions at levels up to 600% over normal (dread only; escape attempts, distress calls, defensive bite attempts; spontaneous anti-predator treading/burying). Yellow sites released both desire and dread in the same rats during the same 1-hour test. Just as a keyboard has many notes, the bars shown in the figure reflect the many graded mixtures of affective desire–dread released as microinjection sites move rostrocaudal location in medial shell (appetitive desire to eat at top; fearful dread reactions at bottom). Adapted from Berridge and Kringelbach (2013) and based on data from Richard and Berridge (2011, 2013). Copyright 2013 by Kringelbach and Berridge. Adapted by permission.

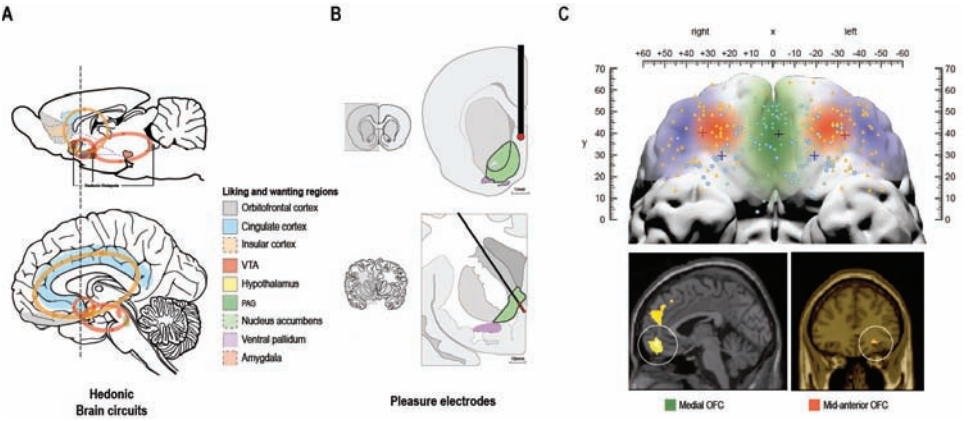

FIGURE 6.4. Brain pleasure networks, "pleasure electrodes," and the orbitofrontal cortex. (A) Pleasure is processed in hedonic networks, where hedonic causation has been identified in rodents as arising from interlinked subcortical hedonic hotspots, such as in the nucleus accumbens and ventral pallidum, where neural activation may increase "liking" expressions to sweetness. Similar pleasure coding and incentive salience networks have also been identified in humans. (B) The so-called "pleasure" electrodes in rodents and humans were unlikely to have elicited much true pleasure, but perhaps only incentive salience or desire. (C) Subjective pleasure is faithfully coded by orbitofrontal cortex (OFC) activations in people. Sensory pleasures appear to be most faithfully represented by a mid-anterior OFC site (orange). Pleasant sensations are also coded by activation in a medial strip of the OFC (green), but the medial strip may not as faithfully track changes in pleasure as the orange mid-anterior site. Smaller symbols show results of a large meta-analysis of 267 orbital areas, which indicated that a medial subregion of the OFC monitored learning and memory of reward values (green area and round blue dots), whereas a lateral orbitofrontal subregion monitored punishers (purple and orange triangles) (Kringelbach & Rolls, 2004). Independently, posterior subregions of the OFC represented complex or abstract reinforcers (such as money), whereas anterior subregions represented sensory rewards such as taste.