learn from the high-status individual. In contrast, hubristic pride seems to underlie the attainment of dominance, a form of high status granted on the basis of intimidation and others' fear of the high-status individual (Tracy, Cheng, & Shariff, 2008). Both forms of high status provide adaptive benefits, although dominance may have done so for a considerably longer time period in our evolutionary history (Henrich & Gil-White, 2001). In contemporary society, personality differences and situational contingencies are likely to determine whether a status-seeking individual makes the appraisals that lead to authentic pride and prestige, or those that lead to hubristic pride and dominance.

Over a century ago, Darwin (1872) included pride within his evolutionary model of emotions and emotion expressions. Empirical findings now support Darwin's view and demonstrate the significance of pride to research in social, personality, clinical, comparative, cultural, developmental, and biological psychology. Specifically, pride appears to be a core social emotion, central to the human need for status and acceptance.

REFERENCES

Darwin, C. (1872). *The expression of the emotions in man and animals* (3rd ed.). New York: Oxford University Press.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion, 6,* 169–200.

Hardy, C. L., & Van Vugt, M. (2006). Nice guys finish first: The competitive altruism hypothesis. *Personality and Social Psychology Bulletin, 32,* 1402–1413.

Henrich, J., & Gil-White, F. J. (2001). The evolution of prestige: Freely conferred deference as a mechanism for enhancing the benefits of cultural transmission. *Evolution and Human Behavior, 22,* 165–196.

Shariff, A. F., & Tracy, J. L. (2008). *Knowing who's boss: Implicit perceptions of status from nonverbal expressions of self-conscious emotions.* Manuscript submitted for publication.

Stipek, D., Recchia, S., & McClintic, S. (1992). *Self-evaluation in young children.* Monographs of the Society for Research in Child Development, *57,* Serial No. 226.

Tracy, J. L., Cheng, J., & Shariff, A. F. (2008). *A naturalist's view of pride.* Invited submission, in preparation.

Tracy, J. L., & Robins, R. W. (2007). The nature of pride. In J. L. Tracy, R. W. Robins, & J. P. Tangney (Eds.), *The self-conscious emotions: Theory and research* (pp. 263–282). New York: Guilford Press.

SUGGESTED READINGS

Tracy, J. L., & Robins, R. W. (2008). The nonverbal expression of pride: Evidence for cross-cultural recognition. *Journal of Personality and Social Psychology, 94,* 516–530.

Tracy, J. L., & Robins, R. W. (2007). The psychological structure of pride: A tale of two facets. *Journal of Personality and Social Psychology, 92,* 506–525.

Tracy, J. L., Robins, R. W., & Tangney, J. P. (2007). *The self-conscious emotions: Theory and research.* New York: Guilford Press.

Jessica L. Tracy
University of British Columbia, Canada

PRIMARY MENTAL ABILITIES

One of the earliest accomplishments of the science of psychology was the objective measurement of mental abilities. In 1904, the British psychologist Charles Spearman argued that intelligence could be characterized as comprising a general factor (*g*), common to all meaningful activity, and of specific factors (*s*) that are unique to the different tasks used to measure intelligence. Binet and Simon (1905) in France and Terman (1916) in the United States introduced test instruments that applied the concept of general intelligence. However, American psychologists engaged in educational and occupational selection activities found the concept of general intelligence not very useful for predicting success in specific jobs or other life roles. In addition, the work of Thorndike and Woodworth (1901) on transfer of training had suggested that the notion of generalizability of a single ability dimension was not justified.

Soon there were efforts to determine whether human abilities could be described along a parsimonious number of distinct substantive dimensions. Initial work along these lines began with the publication of T. L. Kelley's *Crossroads in the Mind of Man* (1928), which advocated the determination of group factors representing distinct skills, such as facility with numbers, facility with verbal materials, spatial relationships, speed, and memory. These efforts were also aided by advances in the methods of factor analysis that allowed the determination of multiple factors, each representing a latent construct represented by sets of independently observed variables.

Most prominently associated with these developments was L. L. Thurstone (1935), who expounded the hope that a careful scrutiny of the relations among a wide array of assessment devices, developed to represent a given construct as purely as possible, would yield a limited number of dimensions that would reflect "the building blocks of the mind." He administered a battery of 56 simple psychological tests to a large number of children in Chicago schools and applied factor analysis to determine the latent basic ability dimensions represented by these tests. Given the procedures available at the time, he was reasonably successful in showing that fewer than 10 latent constructs were required to explain most individual differences' variance in his measures. The factors obtained in this work were consequently labeled primary mental abilities.

The most important factors identified by Thurstone that have subsequently been replicated in others' work are, in order of the proportion of individual differences explained, the following:

1. *Verbal Comprehension (V).* This factor represents the scope of a person's passive vocabulary and is most often measured by multiple-choice recognition vocabulary tests.
2. *Spatial Orientation (S).* The ability to visualize and mentally rotate abstract figures in two- or three-dimensional space. This ability is thought to be involved in understanding maps and charts and in assembling objects that require manipulation of spatial configurations. This may be a complex factor involving both visualization and the perception of spatial relationships.
3. *Inductive Reasoning (R or I).* This is the ability to determine a rule or principle from individual instances, probably involved in most human problem solving. The ability is generally measured by a number or letter series that has several embedded rules; the subject is asked to complete the series correctly.
4. *Number (N).* This is the ability to engage rapidly and correctly in a variety of computational operations. The simplest measure of this ability is a test checking sums for addition problems.
5. *Word Fluency (W).* This factor represents a person's active vocabulary and is generally measured by free recall of words according to a lexical rule.
6. *Associative Memory (M).* Found primarily in verbal tasks involving paired associates or list learning. It is not a general memory factor, evidence for which has not thus far been established.
7. *Perceptual Speed (P).* This ability involves the rapid and accurate identification of visual details, similarities, and differences. This ability is usually measured by letter canceling, simple stimuli, or number comparison tasks.

Other organizational schemes to characterize multiple abilities have been developed by G. H. Thomson (1948) and P. E. Vernon (1960) in England and by J. P. Guilford (1967) in the United States. The last system actually classified tasks along a three-dimensional higher-order hierarchy in terms of content, product, and operations involved in each task, which resulted in a taxonomy of as many as 120 factors, many of which remain to be operationalized.

For purposes of educational application, L. L. Thurstone and T. G. Thurstone (1949) developed a series of tests at several difficulty levels, suitable from kindergarten to high school. These tests were designed to measure Thurstone's first five factors (V, S, R, N, and W). This battery was updated and revised by T. G. Thurstone in 1962. Measures of the other factors may be found in the kit of factor-referenced tests developed by the Educational Testing Service (Ekstrom, French, Harman, & Derman, 1976).

The primary mental abilities measures have had relatively little use in educational practice in recent years. However, these measures experienced a revival as a useful measurement instrument for charting the course of abilities in studies of adult development across the life span. A special version of the primary abilities tests particularly suitable for work with older adults is the Schaie-Thurstone Adult Mental Abilities Test (STAMAT; Schaie, 1985). Factorial invariance of six latent ability dimensions (inductive reasoning, spatial orientation, verbal ability, numeric ability, perceptual speed, and verbal memory) has been demonstrated in longitudinal samples across time and different birth cohorts, as well as across genders. The validity of the primary mental abilities in adults has also been examined with respect to its relation to measures of practical intelligence and subjective perception of competence, as well as to specific occupational outcomes (cf. Schaie, 2005).

REFERENCES

Binet, A., & Simon, T. (1905). Méthodes novelles pour le diagnostic du niveau intellectuel des anormaux. *L'Année Psychologique, 11,* 191.

Ekstrom, R. B., French, J. W., Harman, H., & Derman, D. (1976). *Kit of factor-referenced cognitive tests* (rev. ed.). Princeton, NJ: Educational Testing Service.

Guilford, J. P. (1967). *The nature of human intelligence.* New York: McGraw-Hill.

Kelley, T. L. (1928). *Crossroads in the mind of man: A study of differentiable mental abilities.* Stanford, CA: Stanford University Press.

Schaie, K. W. (1985). *Manual for the Schaie-Thurstone Adult Mental Abilities Test (STAMAT).* Palo Alto, CA: Consulting Psychologists Press.

Schaie, K. W. (2005). *Developmental influences on adult intelligence: The Seattle longitudinal study.* New York: Oxford University Press.

Spearman, C. (1904). "General intelligence": Objectively determined and measured. *American Journal of Psychology, 15,* 201–292.

Terman, L. M. (1916). *The measurement of intelligence.* Boston: Houghton, Mifflin.

Thomson. G. H. (1948). *The factorial analysis of human abilities* (3rd ed.). Boston: Houghton Mifflin.

Thorndike, E. L., & Woodworth, R. S. (1901). Influence of improvement in one mental function upon the efficiency of other mental functions. *Psychological Review, 8,* 247–262, 384–395, 553–564.

Thurstone, L. L. (1935). *Vectors of mind: Multiple-factor analysis for the isolation of primary traits.* Chicago: University of Chicago Press.

Thurstone, L. L., & Thurstone, T. G. (1949). *Examiner manual for the SRA Primary Mental Abilities Test.* Chicago: Science Research Associates.

Vernon, P. E. (1960). *The structure of human abilities* (rev. ed.). London: Methuen.

K. Warner Schaie
Pennsylvania State University

See also: **Adult Intellectual Development; Intellectual Development; Intelligence**

PRIMARY MOTOR CORTEX

The primary motor cortex represents a principal component of sensory motor integration implemented in the brain. Motor cortex has the fundamental function to control voluntary movements, including integration of motor commands with the ongoing somatic sensory state of the body. To accomplish this function, primary motor cortex receives information from sensory, motor-related, and associative cortical and subcortical brain areas and sends massive output monosynaptically to the spinal cord, especially to alpha-motor neurons that couple to muscles. From classical perspectives, the primary motor cortex functions as the final cortical output for already processed movement commands, relaying signals from premotor cerebral cortical sites to the spinal cord. Recent evidence, however, indicates more complex and crucial roles for primary motor cortex in processing motor-related information.

In the past three decades, new concepts have emerged about the function and role of primary motor cortex in movement control. Instead of resembling an automatic piano player superimposed on spinal cord output, primary motor cortex appears to have significant functions related to movement planning and learning. The neural substrate for these higher-order functions of primary motor cortex probably relates to its distributed and plastic anatomical and functional organization.

Motor Cortical Organization

Primary motor cortex has three functional subdivisions, one each for the upper limb, the lower limb, and the head and neck; output from these subdivisions yields the motor commands that elaborate voluntary movement, though other motor-related brain regions, such as the premotor cortical areas in the frontal and parietal lobes, cerebellum, and basal ganglia, also have key roles in shaping motor output. Previous principles of primary motor cortex organization indicated a somatotopic pattern resembling a distorted but recognizable hu
shape—the homunculus—represented on th
of the primary motor cortex. A functional co
of the homuncular arrangement could imply de
specific neural elements, such as a cortical c
controlling one body part, perhaps a finger.

More recent evidence and a more complete
rate reading of the historical record suggest th
motor cortex does not have a regular and organi
totopic pattern within each of the representa
major body part. Instead, circuits in primary
tex exhibit a widely distributed, multiple, and o
representation plan of the different segments o
body parts, though there remains separation b
leg, arm, and head representations. Thus, neu
in primary motor cortex related to finger mov
intermingled and may be shared with circuits f
proximal movements, perhaps to create a su
coordinated actions. The intrinsic anatomica
tion of primary motor cortex also would seem
such a distributed substrate, insofar as pat
mary motor cortex send horizontal connections
throughout a major body representation; these
connections do not appear to extend into other
representations, at least not in nonhuman prim
within the arm representation, local zones ha
nections with many other local zones, thereby
interactions among local circuits that underl
the various individual joints that become in
coordinated multiple-joint action.

A parallel group of studies, done mostly
human primates, has attempted to reveal h
in primary motor cortex encode voluntary
Early approaches to this problem focused
joint movements, such as wrist flexion-ex
described relationships of neural activity in pr
cortex to limb position and exerted force.
work, recognizing that voluntary movemen
coordinating multiple joints within and a
examined so-called higher-order features o
particularly movement direction coding.
these studies found that neurons in pri
cortex—and, indeed, most motor-related stru
neuronal patterns that describe a "movem
analogy to sensory receptive-fields, the mo
of primary motor cortical neurons occupie
direction, or velocity (or combinations ther
the three-dimensional space nearby the bo
the organizational details of movement-field
motor cortex appear to have a distributed pa
like that for individual movements—there
as might be expected, a modest overrepre
movements directed forward and backwar
tion of the temporal dynamics of movemen