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Hubble Space Telescope image of the gaseous ring surrounding supernova 1987A. Representing emissions of visible light from doubly ionized oxygen, this image shows a clumpy, glowing ring 1.37 light-years in diameter. Because the ring is inclined to the line of sight, it appears elliptical. Radio signals from supernova 1987A apparently emanate from a region between this ring and the central object.

Having carefully examining the supernova's belated radio emissions, the Australian team concludes that the signals come from an extended source surrounding the explosion site, rather than from a compact object such as a central pulsar. The bulk of the radio waves appears to emanate from clumps of material that lie between the extinct star and an outlying, well-defined ring of dense gas about 1.37 light-years across, the researchers report.

"This hypothesis is consistent with the absence so far of soft X-ray emission from the region," they note. "Strong X-ray emission is expected when the blast wave encounters the relatively dense ring material."

The apparent width of the radio-emitting region indicates that the supernova blast wave is moving at roughly 30,000 kilometers per second. At this rate, the shock wave's first impact with the outlying ring may occur within a few years, the researchers suggest.

Fluctuations in the intensity of the radio wave emissions at various frequencies provide indirect clues to the geometry and distribution of the gas clumps surrounding the exploded star. Last summer, a rapid increase in the intensity of radiation at 843 megahertz without a corresponding increase at higher frequencies indicated that the blast wave may have reached a new clump of circumstellar gas, the researchers say. As electrons in the new region are accelerated to higher energies, the higher-frequency emissions will probably catch up.

"Further observations will help to establish parameters of the electron acceleration process and the relationship between the radio and [visible-light] emitting regions," the team concludes.

— I. Peterson

School memories endure as time goes by

In contrast to the widespread conviction that the passing years wipe away most recollections of concepts and facts learned in school, a new study has uncovered robust memories among former students for material learned in a college course after as long as 11 years.

Since most study participants believed that within seven years they had lost all memory for what they had learned in the class, the investigators conclude that "acquired knowledge may influence behavior even when an individual is unaware of having retained that knowledge." Martin A. Conway of Lancaster (England) University and his colleagues present their data in the December *JOURNAL OF EXPERIMENTAL PSYCHOLOGY: GENERAL*.

For the most part, the study supports a theory developed by psychologist Harry P. Bahrick of Ohio Wesleyan University in Delaware, Ohio, who holds that much well-learned information remains accessible for up to 50 years, even if an individual never thinks about or uses it after leaving the classroom (SN: 3/10/84, p.149). Bahrick found that people who took Spanish in high school forgot some of what they learned during the six years following completion of classes, but a considerable amount of vocabulary and grammar survived for decades. People who took several Spanish classes and achieved high grades remembered the most.

Conway's group administered memory tests to 373 former students of a yearlong cognitive psychology course taught at a British university between 1978 and 1989. Approximately equal numbers of volunteers had attended each year of the course. The researchers tested participants for recognition of names and concepts covered in the class, ability to verify factual statements about psychological theories, proficiency at sorting psychological concepts into related groups, recall of names and concepts deleted from short statements, and ability to recognize definitions of statistical and research techniques. Participants rated their confidence in each answer and were instructed to guess whenever they could not remember an item.

The average percentage of correctly recalled names and concepts declined in the first three years following the course, dropping from 80 percent to about 70 percent, where it remained for the next eight years. Blind guessing by people who never took a cognitive psychology course would yield an average of 50 percent correct on the recognition tests used in this study, Conway and his co-workers say. Recognition of facts about theories hovered at an average of

65 percent correct for all of the former students, and recognition of research techniques held at an average of 75 percent up to 11 years after students had taken the course.

The average percentage of correctly grouped concepts declined from 57 percent to 35 percent during the three years following course completion and then held relatively steady for eight years. Blind guessing would group only 17 percent of the concepts correctly, the researchers maintain.

Correct recall of names and concepts fell from an average of 60 percent to 25 percent in the three years following the class — still much better than blind guessing. Only name recall improved thereafter, reaching an average of 35 percent correct 11 years after completion of the course.

The findings indicate that students primarily retained specific, detailed facts presented in the course, say the researchers. Little support emerged for the theory that a student develops an abstract mental framework, or "schema," for a particular subject, from which he or she generates educated guesses that produce correct responses to memory tests, they argue.

Moreover, after six or seven years, former students reported no recollection of most names and concepts from the class. Conway and his coauthors say this suggests that performance on the memory tests tapped into "implicit" memory — the unintentional retrieval of previously studied, unconsciously stored information (SN: 11/17/90, p.312).

In the new study, unlike Bahrick's investigation of former Spanish students, higher grades in the course did not strongly predict better recall later on. Conway's team asserts that students with good grades in Bahrick's sample took more than one Spanish course, boosting their long-term memory, whereas the British sample consisted of people who took only one psychology course and for whom grade differences proved less critical.

Bahrick, who says he views the new study as generally supportive of his prior research, offers a different interpretation for the lack of an association between grades and memory. Good grades predict better memory for academic subjects in which previously learned material proves critical for understanding new information, such as mathematics and languages, he contends. Subjects with less emphasis on cumulative learning, such as psychology and history, make possible successful "cramming" before tests, thereby weakening the link between grades and memory, Bahrick asserts. — B. Bower