To learn more about how the gene influences neural migration, the Curran and Cooper teams investigated which brain cells make the mDab protein. The results were gratifying: "mDab is in the cell types affected in the *reeler* and *mdab* mutants," says Howell—the cells that normally respond to Reelin. "Therefore it is possible that [mDab] is acting in those cells to relay a signal."

Researchers now hope they can trace the pathway in which the mDab1 protein apparently acts. The protein's structure and ability to bind to Src suggest it is a "docking protein" that can link a tyrosine kinase like Src to another protein in a signaling pathway. The pathway may be triggered when Reelin binds to an unidentified cell surface receptor, but there's no evidence for that so far.

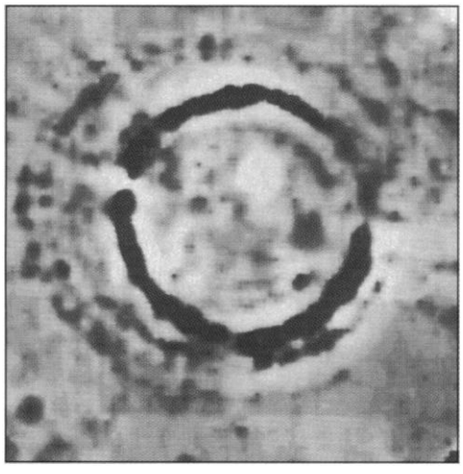
But even if mDab is not activated by Reelin, it is involved in neuronal migration, says Howell, and so may help researchers answer the question of what goes on in the migrating neurons to keep them on target, or, in the case of mutations, throw them off. "What is going wrong isn't that well understood," Howell says. "Having this protein that appears to be working [in the affected neurons] may be very helpful."

–Marcia Barinaga

ARCHAEOLOGY

The Balance of Power in Ancient Ireland

DUBLIN—According to ancient texts, before Christianity came to Ireland about A.D. 400, the country was dominated by three principal kingdoms, the most powerful of which at any one time was the home of the "high" king or queen of Ireland. Their centers of power—at Navan Fort in what is now County Armagh, Northern Ireland; Tara, in County Meath, near Dublin; and Rathcroghan, in County Roscommon in the west—date back as far as 2500 B.C. The kingdoms' struggles for power and prestige are the stuff of Celtic legends that are deeply embedded in the modern Irish consciousness.



KEVIN BARTON/UCG

Bull's-eye. Magnetic survey shows ring structure measuring 20 meters across; fainter rings may have been earlier workings.

Archaeologists have focused most of their attention on Tara and Navan Fort. Rathcroghan, in contrast, has long been considered something of a poor relation. Many archaeologists thought it was less significant than the other two, and was built around a mound formed by nature, rather than by human excavation. Recent geophysical studies of Rathcroghan may, however, change perceptions about the balance of power in ancient Ireland. In its heyday, Rathcroghan may have been more impressive than its two rivals.

A 3-year study by researchers from University College Galway (UCG) has shown that the broad, flat, 7-meter-high mound appears to have been built for ritual purposes, and the enclosure surrounding it is in fact larger than those at Tara and Navan Fort. "Rathcroghan mound is spectacular. It is 90 meters across, and within the mound there are three concentric rings that may represent ring fort settlements from the early Christian period," says John Waddell, one of the team leaders. "Rathcroghan is the [royal] site we know least about. ... It is a spectacular site in terms of the mound and the structures that have been found," says Jim Mallory of Queens University Belfast, who has worked on the Navan Fort site.

The UCG project is the first study of Rathcroghan since archaeologist Michael Herity surveyed its topography in the 1960s. Rather than embarking on excavations straightaway, UCG geophysicist Kevin Barton carried out a detailed subsoil survey. Barton and his colleagues used standard geophysical techniques, including ground-probing radar and magnetic gradiometry, which measures the magnetic properties of subsoil materials, as well as a new tool in the surveyor's armory, electrical tomography. "We were the first in Ireland to use this technique," says Barton.

To carry out electrical tomography, the team placed metal electrodes into the ground and passed a current between them through the subsoil, measuring its resistivity, which varies depending on what it is made of. Using a large number of such measurements taken in different directions and at various depths, the team used computer modeling to construct vertical "slices" of the subsurface and then built these up into a three-dimensional image of the interior of the mound.

The geophysical survey produced a wealth of new information about Rathcroghan: evidence of ditches, walls, postholes indicating structures and fences, and different phases of building in the mound. "Geophysics has completely changed our interpretation of Rathcroghan mound," says Waddell. "We now know that it is a very complicated site with a prolonged history of human activity. ... The mound is, without doubt, [humanmade] ... indicating that a large amount of labor was invested here, suggesting an organized society with an element of leadership." Eoin Grogan, an archaeologist working for the Irish government's Discovery Programme who has studied the Tara site, says, "We now know that geophysics works. This is an impressive piece of research that has produced exciting evidence."

The size of the Rathcroghan complex was a big surprise. It is 370 meters from the middle of the central mound to a circular enclosure where the team found postholes, indicating the presence of a wooden perimeter fence. This is almost double the size of the 200-meter enclosures at Tara and Navan Fort.

Many of the team's discoveries are reminiscent of features found at Tara and Navan Fort and support archaeologists' earlier conclusions that these sites were used for important rituals, such as the inauguration or burial of kings and queens. For example, the team found, through the use of magnetic techniques, what they believe to be repeated burnings on and around the mound and also linear earthworks leading into the mound—similar to the "ritual roadways" found at Tara. In contrast to other large Celtic sites, there is no evidence of settlement within the enclosure in the pre-Christian period, suggesting that the huge area of open ground between the mound and the enclosure was used for large-scale rituals in pagan times. "We are now asking, 'What is the significance of the sheer complexity of Rathcroghan?' " says Waddell. "This will be one of the hardest nuts to crack. How do we interpret the beliefs of ancient peoples?"

This month, the team will present a final report on the study to the Irish Heritage Council, which funded the work, identifying areas for future digs. But Waddell says the prevailing mood is against rushing into excavations, as there is still much to be learned with geophysical techniques. Says geophysicist Andrew David of the British conservation organization English Heritage: "If these techniques are used judiciously in the future, I believe that Ireland has tremendous potential for new discoveries."

–Sean Duke

Sean Duke is a science writer in Dublin.