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The Brazil nut effect gets more jumbled

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Shake a can of mixed nuts long enough and the biggest nuts end up on top. Studied since the 1930s but still poorly understood, this phenomenon–called the Brazil nut effect–also occurs in batches of particles ranging from stones to powders.

The phenomenon is of more than academic interest. In drug manufacturing, for instance, such separations could lead to unevenly blended powders. That could throw off dosages in pills made from the mixtures.

E. Roell

In recent years, researchers found that the weights of particles in a granular mix–not just the grains' different sizes–are important factors in the Brazil nut effect. Now, a new experiment shows that the nature of the particles alone isn't enough to explain what's going on.

Sidney R. Nagel and Heinrich M. Jaeger, both of the University of Chicago, and their colleagues find that the air around the grains also plays a vital role. What's more, the effect of a particle's weight is more complex than previously reported, the researchers say.

They've issued "a wake-up call," comments Robert P. Behringer of Duke University in Durham, N.C. The Brazil nut effect was already "a pretty perplexing problem, and they've upped the ante of what we'll have to unravel if we ever hope to understand it," he says. The Chicago team reports its findings in the Nov. 15 *Nature*.

Around a decade ago, the prevailing account of the Brazil nut effect held that smaller particles in a shaking container fill in transient gaps that open beneath the larger particles. This makes the big guys rise (SN: 3/28/87, p. 201). To be sure, that's still part of the explanation.

Experiments by Nagel, Jaeger, and their collaborators in the early 1990s revealed that granular materials in a shaken cylinder undergo a convective flow, rising at the middle and falling at the sides (SN: 6/26/93, p. 405). This churning strands big bits at the top. Experiments indicating that heavier bits rise faster than lighter ones of the same size have more recently demonstrated that particle density also plays a role.

To look deeper into the contribution of particle density to the Brazil nut effect, the Chicago researchers shook a gumball-size acrylic shell that they had placed in a mug-size cylinder filled with smaller particles, such as glass beads or poppy seeds. To vary the acrylic ball's density, the researchers filled it with varying amounts of lead shot, explains team member Matthias E. Möbius.

After pushing the big ball down into the surrounding particles, the researchers sealed the container, placed it on a mechanical shaker, and measured the ball's motion. Much to their surprise, the researchers found that at normal pressure both the heaviest and the lightest of the big balls moved to the top ahead of balls of intermediate weight, Möbius says.

The scientists also pulled increasing amounts of air out of the cylinder to see how the gas in the system affected the results. The weight-dependent variation eventually vanished. Moreover, in the evacuated cylinder, a ball of almost any weight rose faster than it would in normal pressure.

No one has yet explained the new results, Nagel says. His team is planning additional experiments to determine how air affects the movement of the small particles. For now, anyway, the Brazil nut effect continues to vex scientists.