



Behavior Recognition Technology

TubeScan

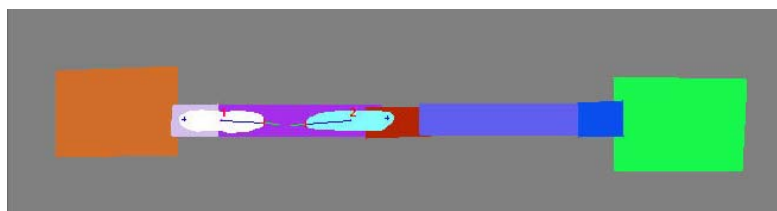
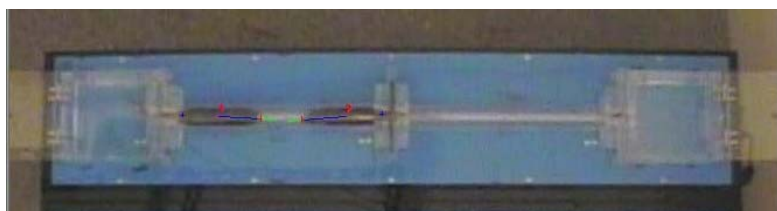
Automated Systems for
Social Hierarchy

TubeScan is our latest addition to our product lines for social dominance hierarchy, to complement our RFID-Assisted SocialScan system. While RFID-Assisted SocialScan system looks at the free interactions between multiple animals in the same arena, *TubeScan* was developed as a paradigm to score social dominance in laboratory rodents. After mice or rats are trained to walk through a narrow tube, a nonviolent conflict situation is created when two rodents are allowed to enter the tube from opposite ends and meet in the middle. The one that consistently forces the opponent to retreat is scored as the more dominant of the pair. By applying a round-robin match arrangement, the rank order can be determined for any size of social group. This assay shows good stability and transitivity when applied to either unfamiliar mice from different inbred strains or familiar cage-mates from the same strain!

TubeScan is analogous to our DSRScan. Instead of an automated door separating the two animals from the two ends of the tube, DSRScan uses a milk bowl in the middle, and the test is to observe which one is going to dominate access to the milk.

The behavioral apparatus consists of a ventilated transparent 50cm long fiberglass tube with an opaque center door, which is connected at both ends to identical fiberglass boxes (12 x 8 cm) through automated opaque entrance doors. The box in which a mouse is initially placed is called the “starting box”, while the box at the opposite end would be the “goal box”. The inner diameter of the tube (2.5cm) is sufficiently wide to allow a single mouse to comfortably walk through, but not for two mice to pass each other.

Using a camera, the associated *TubeScan* software records and analyzes the video to track each animal, identify their important body parts like nose, tail, and body center to determine its movement directions, such as forward motion and backtracking. A control unit is integrated with the *TubeScan* software that controls the opening and closing of the 3 automatic doors based on the two animals' positions and behaviors. All these operations and behavior detections are performed in real-time. The top of the tube has a slit of 1 cm wide that allows cables for optogenetics or mini-scope camera or EEG to go through while the animal moves freely, but does not the mice to escape.



Left image shows the Tube with the two animals competing for dominance. Both animals are occupying the Left subject's area implying that the Right subject is dominating the Left subject. The Right image shows the tracking analysis as well as the layout of the Tube Design in the *TubeScan* software.

TubeScan

Once the two mice are in their start boxes and they enter the tube from their respective ends, we need to make sure that they do not go back to the start box so the side door needs to close once the mouse leaves their respective start boxes. The mice should not start interacting before they are both at the middle of the tube in order to standardize the test, which is why the middle door needs to automatically open when *both* mice are at the midpoint. At that instant, the middle door as well as the two side doors open and the mice start interacting and the main portion of the match begins. The winning mouse will push the losing mouse into its start box and once the loser mouse has all four legs in its start box, that corresponding side door should close to stop any further interaction of the mice.

Event Statistics		Social Distance Statistics	Signal	Debug Information					
Arena	Criteria	Bouts	Duration	%	Latency	Dist (mm)	V (mm/s)		
1	Area:Mouse 1 Center In Left Box	0	0.00	0.0					
1	Area:Mouse 1 Center In Left Tube	4	14.11	20.1	50.95	2.77	0.20		
1	Area:Mouse 1 Center In Middle Gate	4	56.29	80.0	0.00	51.77	0.94		
1	Area:Mouse 1 Center In Right Tube	0	0.00	0.0					
1	Area:Mouse 1 Center In Right Box	0	0.00	0.0					
1	Area:Mouse 2 Center In Left Box	0	0.00	0.0					
1	Area:Mouse 2 Center In Left Tube	0	0.00	0.0					
1	Area:Mouse 2 Center In Middle Gate	4	66.47	94.5	0.13	31.96	0.49		
1	Area:Mouse 2 Center In Right Tube	3	3.80	5.4	1.97	4.80	1.26		
1	Area:Mouse 2 Center In Right Box	0	0.00	0.0					
1	Animal 1 and 2 Stay Area Left Tube at s...	0	0.00	0.0					
1	Animal 1 and 2 Stay Area Middle Gate at...	7	52.35	74.4	0.13	43.19	0.84		
1	Animal 1 and 2 Stay Area Right Tube at ...	0	0.00	0.0					
1	Animal 1 push Animal 2	1	64.33	91.4	0.00	43.84	0.69		
1	Animal 2 push Animal 1	0	0.00	0.0					
1	Animal 1 Resist from Animal 2	1	4.20	6.0	64.33	2.70	0.64		
1	Animal 2 Resist from Animal 1	1	64.33	91.4	0.00	28.69	0.45		
1	Animal 1 Retreat	1	1.87	2.7	68.54	8.00	4.28		
1	Animal 2 Retreat	0	0.00	0.0					
1	Animal 1 and 2 Contact in Area Left Box	0	0.00	0.0					
1	Animal 1 and 2 Contact in Area Left Tube	3	3.60	5.1	64.33	0.00	0.00		
1	Animal 1 and 2 Contact in Area Middle Gate	3	65.13	92.6	0.27	54.54	0.85		
1	Animal 1 and 2 Contact in Area Right Tube	0	0.00	0.0					
1	Animal 1 and 2 Contact in Area Right Box	0	0.00	0.0					
1	TTLOut 1: After Analyzing Duration > ...	1	30.76	43.7	0.00	0.00	0.00		
1	TTLOut 2: After Analyzing Duration > ...	1	30.76	43.7	0.00	0.00	0.00		
1	TTLOut 3: Area:Mouse 1 Center In Left T...	1	1.94	2.8	51.28	0.00	0.00		
1	TTLOut 4: Area:Mouse 2 Center In Right ...	1	1.47	2.1	2.30	0.00	0.00		
1	TTLOut 5: Animal 1 and 2 Stay Area Midd...	1	1.87	2.7	0.47	0.00	0.00		
1	TTLOut 6: Animal 1 and 2 Stay Area Midd...	1	1.87	2.7	0.47	0.00	0.00		
1	TTLOut 7: Animal 1 and 2 Stay Area Midd...	1	1.87	2.7	0.47	0.00	0.00		

Events Detected

- Area CoStay
- Contact
- Push and Resist
- PushBack
- Retreat
- Still

Applications

- Social Interaction Studies
- Social Hierarchy Studies
- Dominance-Submissive Studies
- Autism Studies

Parameters Provided:

- Basic parameters such as Number of Bouts and Duration of each Event
- Distance Traveled and Speed
- Winner Animal ID
- Duration of Session
- Latency to each event such as Latency to enter tube, etc
- The animal ID and Latency to enter tube first.
- The animal ID and Latency to enter middle door area first.
- Latency to when both animals enter the middle door area.
- And many more!