

# Lecture Summary: Unit 11 - Disorders of the Nervous System

This comprehensive lecture covers neurological and psychiatric disorders, their underlying mechanisms, and emerging treatment approaches.

## Motor System Disorders

The lecture begins by reviewing the four essential systems for motor control: spinal cord circuits, cerebellum, descending control centers in cortex/brainstem, and basal ganglia. Key disorders discussed include:

**ALS (Amyotrophic Lateral Sclerosis):** A devastating disease targeting motor neurons that send messages from brain to muscles. Patients progressively lose ability to walk, speak, swallow, and breathe, typically fatal within 2-5 years of diagnosis. Symptoms begin with limb weakness, progressing to widespread motor dysfunction, breathing difficulties, and paralysis.

**Cerebellar Ataxia:** Damage to the cerebellum impairs motor learning and control, affecting approximately 4 in 100,000 people. Patients show poorly coordinated movements with irregular trajectories, overshooting or undershooting targets.

## Emerging Therapeutic Approaches

The lecture highlights revolutionary bioengineering opportunities using iPSCs (induced pluripotent stem cells) and organoids. Shinya Yamanaka's discovery of four transcription factors that make adult cells pluripotent has enabled patient-specific drug screening for diseases like ALS. Cerebral organoids model human brain development, though challenges remain for cell replacement therapy and in vivo regeneration.

Brain-machine interfaces represent another frontier, using motor cortex signals to control prosthetic limbs or restore communication.

## Psychiatric Disorders

**Alzheimer's Disease:** Affects nearly half of people 85+ years old, characterized by progressive memory loss, disorientation, senile plaques, and neurofibrillary tangles. Four genes are associated with familial forms.

**Depression:** The most common major psychiatric disorder (lifetime prevalence 10-25% in women, 5-12% in men). Brain imaging shows increased blood flow in the amygdala and prefrontal cortex. Treatments include SSRIs like Prozac, which selectively block serotonin reuptake.

**Schizophrenia:** Affects 1% of the population with positive symptoms (delusions, hallucinations) and negative symptoms (apathy, diminished expression). The economic burden exceeds \$343 billion annually in the US. Dopamine receptor antagonists reduce psychotic symptoms, but apathy remains a major unmet need affecting daily functioning and quality of life.

## Precision Psychiatry and Future Directions

The lecture emphasizes the shift from "one size fits all" to precision psychiatry approaches. Transcranial Magnetic Stimulation (TMS) offers non-invasive brain stimulation that can modulate specific brain networks. Different prefrontal cortex stimulation sites preferentially affect different network subsets, enabling personalized treatment.

Advanced technologies are transforming clinical applications:

- **Ecological neuroscience:** Moving beyond simple lab tests to practical tools like the EPFL-Smart-Kitchen Platform for ethological assessments
- **AI systems:** AmadeusGPT leverages large language models combined with computer vision to quantify behavior at human-level performance
- **Neural decoding:** CEBRA algorithm enables joint modeling of neural and behavioral data for brain-machine interfaces

The lecture concludes by highlighting the integration of ethological computational psychiatry—measuring and modeling adaptive behavior from bench to clinical applications, with ongoing studies using tools like DeepLabCut in multiple locations including Bern.

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## Summary Notes

### Motor Disorders

- **ALS (Lou Gehrig's Disease):** Progressive loss of motor neurons → paralysis (fatal 2-5 years)
- **Cerebellar Ataxia:** Impaired motor coordination and learning (~4/100,000 affected)
- **Alzheimer's Disease:** Memory loss, plaques & tangles (affects ~50% of 85+ population)

# Psychiatric Disorders

- **Depression:** Most common psychiatric disorder (10-25% lifetime prevalence)
- **Schizophrenia:** 1% prevalence, \$343B US economic burden

# Treatment Innovations

## Bioengineering

- iPSC technology for patient-specific drug screening
- Cerebral organoids modeling brain development
- Brain-machine interfaces for motor restoration

## Precision Psychiatry

- TMS (Transcranial Magnetic Stimulation) for personalized treatment
- Advanced neuroimaging to target specific brain networks
- Shift from "one size fits all" to individualized approaches

# Future Directions

- **Ecological neuroscience:** Real-world behavioral assessments (EPFL-Smart-Kitchen)
- **AI-powered tools:** AmadeusGPT for behavior quantification
- **Neural decoding:** CEBRA algorithm linking brain activity to behavior
- **Ethological computational psychiatry:** Bench-to-bedside translation

*From understanding circuits to personalized treatments*