**Supplementary Materials**

**S1:**  Learning Material and 22 Idea Units in Script

Chemical synaptic transmission between neurons mainly occurs in the presynaptic membrane, synaptic gap and the postsynaptic membrane (1). The transfer process needs more steps to complete (2).

Action potentials, the presynaptic neurons are generated, and transmitted to the presynaptic membrane of nerve terminals (3). The arrival of action potentials induces depolarization of presynaptic membrane (4). Thus this intensifies the voltage gated Ca2+ channel on the presynaptic membrane, and permeability of Ca2+ is enhanced (5). At this point, Ca2+ in the extracellular enters into the presynaptic membrane through the channel, which leads to increasing the concentration of Ca2+ in the presynaptic membrane (6). The entry of Ca2+ may prompt the synaptic vesicle to move to the presynaptic membrane (7), and synaptic vesicle fuses with presynaptic membrane, then a cleft appears in the presynaptic membrane (8). The neurotransmitter in the synaptic vesicle is released into the synaptic gap through the role of the cell (9). These neurotransmitters arrive at the postsynaptic membrane by diffusion (10), and are combined with specific receptors on the postsynaptic membrane (11). The combination of neurotransmitters and receptors changes ion’s permeability of the postsynaptic membrane, and some ion channels open (12). Ions begin to move across the membrane, for example, Na+ flows into the postsynaptic membrane (13), and changes the membrane potential of the postsynaptic membrane, which eventually leads to the postsynaptic potential depolarization or super polarization (14).

In order to compensate for the reduction in the number of synaptic vesicles (15), new vesicles will be re-produced under the action of the related proteins on the presynaptic membrane (16). The released neurotransmitter has an inactivation mechanism, it mainly includes three ways: First is enzyme degradation (17). Neurotransmitters that combined with receptor in the synaptic cleft, are rapidly degraded by neurotransmitter enzyme (18). Second is the diffusion (19). That is, a part of neurotransmitters leaves the synapse through passive diffusion (20). Third is to reuptake (21). That is, another part of neurotransmitters is re-ingested in the presynaptic membrane (22).

**Table S2:** Summary of all relative indirect effects on retention

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Effect | Boot SE | Boot LLCI | Boot ULCI |
| Teaching condition → State anxiety → Retention | X1 | 0.007 | 0.032 | ˗0.044 | 0.093 |
| X2 | 0.027 | 0.067 | ˗0.103 | 0.180 |
| Teaching condition → Perceived difficulty → Retention | X1 | ˗0.056 | 0.062 | ˗0.210 | 0.028 |
| X2 | ˗0.059 | 0.063 | ˗0.216 | 0.029 |
| **Teaching condition → Idea units →Retention** | **X1** | **˗0.301** | **0.107** | **˗0.518** | **˗0.099** |
| **X2** | **˗0.321** | **0.094** | **˗0.520** | **˗0.151** |
| Teaching condition → State anxiety → Perceived difficulty → Retention | X1 | ˗0.010 | 0.018 | ˗0.053 | 0.023 |
| X2 | ˗0.036 | 0.033 | ˗0.107 | 0.027 |
| Teaching condition → State anxiety → Idea units → Retention | X1 | ˗0.018 | 0.031 | ˗0.094 | 0.029 |
| X2 | ˗0.066 | 0.048 | ˗0.182 | 0.001 |
| **Teaching condition → Perceived difficulty → Idea units → Retention** | X1 | ˗0.075 | 0.052 | ˗0.191 | 0.004 |
| **X2** | **˗0.079** | **0.047** | **˗0.185** | **˗0.003** |
| **Teaching condition → State anxiety → Perceived difficulty → Idea units → Retention** | X1 | ˗0.013 | 0.021 | ˗0.065 | 0.019 |
| **X2** | **˗0.047** | **0.029** | **˗0.118** | **˗0.008** |
| **Total effects** | X1 | ˗0.316 | 0.244 | ˗2.680 | 0.566 |
| **X2** | **˗0.724** | **0.242** | **˗4.027** | **˗0.817** |
| Direct effects | X1 | 0.150 | 0.226 | ˗1.001 | 2.007 |
| X2 | ˗0.143 | 0.233 | ˗2.026 | 1.069 |

Note: These effects are standardized. Significant indirect, total, and direct effects have been highlighted in bold (at *p* < .05). Teaching condition was the indicator-coded predictor (teach-to-video condition as reference, Dummy variable X1 was coded as 1 on the teach-to-student condition, and X2 was coded as 1 on the teach-to-group condition).

**Table S3:** Summary of all relative indirect effects on transfer

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Effect | Boot SE | Boot LLCI | Boot ULCI |
| Teaching condition → State anxiety → Transfer | X1 | ˗0.017 | 0.036 | ˗0.108 | 0.036 |
| X2 | ˗0.062 | 0.064 | ˗0.216 | 0.040 |
| Teaching condition → Perceived difficulty → Transfer | X1 | ˗0.072 | 0.058 | ˗0.203 | 0.018 |
| X2 | ˗0.076 | 0.063 | ˗0.229 | 0.014 |
| **Teaching condition → Idea units → Transfer** | **X1** | **˗0.261** | **0.094** | **˗0.458** | **˗0.090** |
| **X2** | **˗0.278** | **0.097** | **˗0.494** | **˗0.115** |
| Teaching condition → State anxiety → Perceived difficulty → Transfer | X1 | ˗0.013 | 0.019 | ˗0.059 | 0.022 |
| X2 | ˗0.045 | 0.032 | ˗0.120 | 0.009 |
| **Teaching condition → State anxiety → Idea units → Transfer** | X1 | ˗0.016 | 0.025 | ˗0.074 | 0.027 |
| **X2** | **˗0.058** | **0.036** | **˗0.140** | **-0.001** |
| **Teaching condition → Perceived difficulty → Idea units → Transfer** | X1 | ˗0.065 | 0.046 | ˗0.174 | 0.005 |
| **X2** | **˗0.068** | **0.041** | **˗0.159** | **˗0.003** |
| **Teaching condition → State anxiety → Perceived difficulty → Idea units → Transfer** | X1 | ˗0.011 | 0.019 | ˗0.057 | 0.020 |
| **X2** | **˗0.041** | **0.027** | **˗0.110** | **˗0.008** |
| **Total effects** | **X1** | **˗0.790** | **0.220** | **˗5.391** | **˗1.551** |
| **X2** | **˗0.968** | **0.218** | **˗6.152** | **˗2.355** |
| Direct effects | X1 | ˗0.336 | 0.189 | ˗3.126 | 0.179 |
| X2 | ˗0.341 | 0.195 | ˗3.199 | 0.202 |

Note: These effects are standardized. Significant indirect, total, and direct effects have been highlighted in bold (at *p* < .05). Teaching condition was the indicator-coded predictor (teach-to-video condition as reference, Dummy variable X1 was coded as 1 on the teach-to-student condition, and X2 was coded as 1 on the teach-to-group condition).

**Table S4:** Summary of all relative indirect effects on retention of the specific mediational pathway of teaching activity to difficulty to generative processing to learning outcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Effect | Boot SE | Boot LLCI | Boot ULCI |
| Teaching condition → Perceived difficulty → Retention | X1 | ˗0.060 | 0.065 | ˗0.220 | 0.036 |
| X2 | ˗0.085 | 0.081 | ˗0.272 | 0.049 |
| **Teaching condition → Idea units →Retention** | **X1** | **˗0.291** | **0.110** | **˗0.519** | **˗0.090** |
| **X2** | **˗0.347** | **0.096** | **˗0.547** | **˗0.171** |
| **Teaching condition → Perceived difficulty → Idea units → Retention** | **X1** | **˗0.108** | **0.063** | **˗0.244** | **˗0.004** |
| **X2** | **˗0.154** | **0.059** | **˗0.283** | **˗0.053** |
| **Total effects** | X1 | ˗0.321 | 0.243 | ˗2.691 | 0.544 |
| **X2** | **˗0.738** | **0.240** | **˗4.062** | **˗0.874** |
| Direct effects | X1 | 0.137 | 0.224 | ˗1.029 | 1.947 |
| X2 | ˗0.151 | 0.230 | ˗2.034 | 1.021 |

Note: These effects are standardized. Significant indirect, total, and direct effects have been highlighted in bold (at *p* < .05). Teaching condition was the indicator-coded predictor (teach-to-video condition as reference, Dummy variable X1 was coded as 1 on the teach-to-student condition, and X2 was coded as 1 on the teach-to-group condition).

**Table S5:** Summary of all relative indirect effects on transfer of the specific mediational pathway of teaching activity to difficulty to generative processing to learning outcomes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Effect | Boot SE | Boot LLCI | Boot ULCI |
| **Teaching condition → Perceived difficulty → Transfer** | X1 | ˗0.100 | 0.064 | ˗0.249 | 0.004 |
| **X2** | **˗0.143** | **0.078** | **˗0.319** | **˗0.019** |
| **Teaching condition → Idea units → Transfer** | **X1** | **˗0.271** | **0.098** | **˗0.470** | **˗0.088** |
| **X2** | **˗0.323** | **0.094** | **˗0.524** | **˗0.167** |
| **Teaching condition → Perceived difficulty → Idea units → Transfer** | **X1** | **˗0.100** | **0.060** | **˗0.233** | **˗0.005** |
| **X2** | **˗0.144** | **0.054** | **˗0.262** | **˗0.053** |
| **Total effects** | **X1** | **˗0.792** | **0.219** | **˗5.386** | **˗1.568** |
| **X2** | **˗0.972** | **0.216** | **˗6.152** | **˗2.389** |
| Direct effects | X1 | ˗0.321 | 0.188 | ˗3.048 | 0.231 |
| X2 | ˗0.363 | 0.193 | ˗3.277 | 0.089 |

Note: These effects are standardized. Significant indirect, total, and direct effects have been highlighted in bold (at *p* < .05). Teaching condition was the indicator-coded predictor (teach-to-video condition as reference, Dummy variable X1 was coded as 1 on the teach-to-student condition, and X2 was coded as 1 on the teach-to-group condition).