RATIOMERA

Complete Solutions

Partial Correlation

Ratiomera Statistics

These complete solutions use the same identifiers and order as the Exercise Sheet. Intermediate values are retained until the stated rounding step, so small differences caused by earlier rounding are acceptable where noted. All settings, values, data, and software outputs are constructed teaching material; they are not empirical findings.

Part I: Theory

A02: Comparing Bivariate and Partial Correlation

`T06-A02-V01`: Practice, prior knowledge, and reasoning

Identify the issue

One plausible diagram is **Z ⟶ X, Z ⟶ Y, and X ↔ Y**.

It connects prior knowledge with both weekly practice and reasoning score; the focal X-Y link remains a separate association.

In this setting, prior knowledge is positively related to both practice and reasoning, so part of the bivariate association reflects their shared connection with it.

Reason through the evidence

The coefficient changes from 0.68 to 0.34, so adjustment makes the absolute association weaker.

Residualization first predicts weekly practice from prior knowledge and predicts reasoning score from prior knowledge; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending prior knowledge as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

`T06-A02-V02`: Search time, experience, and accuracy

Identify the issue

One plausible diagram is **Z ⟶ X, Z ⟶ Y, and X ↔ Y**.

It connects archive experience with both search time and accuracy; the focal X-Y link remains a separate association.

In this setting, experience tends to shorten searches and improve accuracy, creating part of the negative bivariate relationship.

Reason through the evidence

The coefficient changes from −0.57 to −0.26, so adjustment makes the absolute association weaker.

Residualization first predicts search time from archive experience and predicts accuracy from archive experience; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending archive experience as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

`T06-A02-V03`: Reading time, workload, and comprehension

Identify the issue

One plausible diagram is **Z ⟶ X, Z ⟶ Y, and X ↔ Y**.

It connects course workload with both reading time and comprehension; the focal X-Y link remains a separate association.

In this setting, high workload is associated with more reading but lower comprehension, suppressing part of the positive adjusted relationship.

Reason through the evidence

The coefficient changes from 0.18 to 0.41, so adjustment makes the absolute association stronger.

Residualization first predicts reading time from course workload and predicts comprehension from course workload; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending course workload as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

`T06-A02-V04`: Notifications, task load, and focus

Identify the issue

One plausible diagram is **Z ⟶ X, Z ⟶ Y, and X ↔ Y**.

It connects task load with both notification count and focus; the focal X-Y link remains a separate association.

In this setting, heavier task load can increase notifications and reduce focus, accounting for part of the raw negative association.

Reason through the evidence

The coefficient changes from −0.49 to −0.20, so adjustment makes the absolute association weaker.

Residualization first predicts notification count from task load and predicts focus from task load; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending task load as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

`T06-A02-V05`: Museum visits, education, and knowledge

Identify the issue

One plausible diagram is **Z ⟶ X, Z ⟶ Y, and X ↔ Y**.

It connects education with both museum visits and historical knowledge; the focal X-Y link remains a separate association.

In this setting, education may encourage visits and support historical knowledge, so the raw association partly reflects this common connection.

Reason through the evidence

The coefficient changes from 0.54 to 0.29, so adjustment makes the absolute association weaker.

Residualization first predicts museum visits from education and predicts historical knowledge from education; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending education as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

`T06-A02-V06`: Route familiarity, distance, and travel time

Identify the issue

One plausible diagram is **Z → X, Z → Y, and X ↔ Y**.

It connects route distance with both route familiarity and travel time; the focal X-Y link remains a separate association.

In this setting, longer routes can be more familiar yet still take longer, hiding part of the negative familiarity-time relationship.

Reason through the evidence

The coefficient changes from −0.21 to −0.48, so adjustment makes the absolute association stronger.

Residualization first predicts route familiarity from route distance and predicts travel time from route distance; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending route distance as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

`T06-A02-V07`: Workshop attendance, baseline confidence, and final confidence

Identify the issue

One plausible diagram is **Z → X, Z → Y, and X ↔ Y**.

It connects baseline confidence with both attendance and final confidence; the focal X-Y link remains a separate association.

In this setting, learners who begin more confident may attend more and also finish more confident.

Reason through the evidence

The coefficient changes from 0.61 to 0.25, so adjustment makes the absolute association weaker.

Residualization first predicts attendance from baseline confidence and predicts final confidence from baseline confidence; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending baseline confidence as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

`T06-A02-V08`: Task switching, workload, and completion

Identify the issue

One plausible diagram is **Z ⟶ X, Z ⟶ Y, and X ↔ Y**.

It connects workload with both task switching and completion score; the focal X-Y link remains a separate association.

In this setting, workload can increase switching and make completion harder, producing part of the raw negative relationship.

Reason through the evidence

The coefficient changes from −0.52 to −0.28, so adjustment makes the absolute association weaker.

Residualization first predicts task switching from workload and predicts completion score from workload; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending workload as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

`T06-A02-V09`: Discussion posts, engagement, and reasoning

Identify the issue

One plausible diagram is **Z ⟶ X, Z ⟶ Y, and X ↔ Y**.

It connects general engagement with both discussion posts and reasoning score; the focal X-Y link remains a separate association.

In this setting, engagement may lead to both more posts and higher reasoning scores.

Reason through the evidence

The coefficient changes from 0.59 to 0.19, so adjustment makes the absolute association weaker.

Residualization first predicts discussion posts from general engagement and predicts reasoning score from general engagement; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending general engagement as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

T06-A02-V10: Practice regularity, total time, and retention
Identify the issue

One plausible diagram is **Z ⟶ X, Z ⟶ Y, and X ↔ Y**.

It connects total study time with both practice regularity and retention; the focal X-Y link remains a separate association.

In this setting, total time is positively related to both variables but can also blur the distinct contribution of regular scheduling in the bivariate coefficient.

Reason through the evidence

The coefficient changes from 0.33 to 0.47, so adjustment makes the absolute association stronger.

Residualization first predicts practice regularity from total study time and predicts retention from total study time; the partial correlation is the correlation between what remains in those two columns.

A smaller coefficient suggests that the control variable accounts for part of the bivariate pattern.

A larger coefficient suggests suppression, where adjustment reveals a relationship that was partly hidden.

State the conclusion and its limits

Neither result establishes time order, rules out unmeasured variables, repairs measurement error, or replaces experimental control.

Defending total study time as a control requires subject-matter and research-design reasons, including a plausible time order and a clear account of the role assigned to the variable.

The coefficients alone cannot supply that justification.

Linear adjustment can remove only the fitted linear component under the stated model, so nonlinear structure, measurement problems, and relevant unmeasured variables may remain.

Part II: Calculator Practice

A01: Partial Correlation by Residualization and by Formula

T06-A01-V01: Practice and reasoning after prior score
Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = 15.4000$, while $\sum e_X^2 = 28.0000$ and $\sum e_Y^2 = 12.1171$.

Work through the calculation

Thus $r(e_X, e_Y) = 15.4000/\sqrt{28.0000(12.1171)} = 0.8361$.

The direct formula gives $[0.8761 - (0.5200)(0.4800)]/\sqrt{[1-(0.5200)^2][1-(0.4800)^2]} = 0.8361$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.

T06-A01-V02: Search time and accuracy after experience

Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = -12.1000$, while $\sum e_X^2 = 28.0000$ and $\sum e_Y^2 = 9.6200$.

Work through the calculation

Thus $r(e_X, e_Y) = -12.1000/\sqrt{28.0000(9.6200)} = -0.7373$.

The direct formula gives $[-0.7997 - (-0.4600)(0.5500)]/\sqrt{[1-(-0.4600)^2][1-(0.5500)^2]} = -0.7373$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.

T06-A01-V03: Reading and comprehension after prior knowledge

Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = 13.8000$, while $\sum e_X^2 = 42.0000$ and $\sum e_Y^2 = 8.6971$.

Work through the calculation

Thus $r(e_X, e_Y) = 13.8000/\sqrt{42.0000(8.6971)} = 0.7220$.

The direct formula gives $[0.7834 - (0.5800)(0.4400)]/\sqrt{[1-(0.5800)^2][1-(0.4400)^2]} = 0.7220$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.

T06-A01-V04: Notifications and focus after workload

Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = -9.9000$, while $\sum e_X^2 = 28.0000$ and $\sum e_Y^2 = 7.4800$.

Work through the calculation

Thus $r(e_X, e_Y) = -9.9000/\sqrt{28.0000(7.4800)} = -0.6841$.

The direct formula gives $[-0.7628 - (-0.5100)(0.4900)]/\sqrt{[1-(-0.5100)^2][1-(0.4900)^2]} = -0.6841$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.

T06-A01-V05: Museum visits and knowledge after education

Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = 9.2000$, while $\sum e_X^2 = 42.0000$ and $\sum e_Y^2 = 5.3743$.

Work through the calculation

Thus $r(e_X, e_Y) = 9.2000/\sqrt{42.0000(5.3743)} = 0.6124$.

The direct formula gives $[0.7074 - (0.4700)(0.5300)]/\sqrt{[1-(0.4700)^2][1-(0.5300)^2]} = 0.6124$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.

T06-A01-V06: Route familiarity and travel time after distance

Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = -11.6000$, while $\sum e_X^2 = 28.0000$ and $\sum e_Y^2 = 7.8400$.

Work through the calculation

Thus $r(e_X, e_Y) = -11.6000/\sqrt{28.0000(7.8400)} = -0.7829$.

The direct formula gives $[-0.8235 - (-0.4300)(0.6000)]/\sqrt{[1-(-0.4300)^2][1-(0.6000)^2]} = -0.7829$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.

T06-A01-V07: Workshop attendance and confidence after baseline

Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = 15.0000$, while $\sum e_X^2 = 42.0000$ and $\sum e_Y^2 = 8.1771$.

Work through the calculation

Thus $r(e_X, e_Y) = 15.0000/\sqrt{42.0000(8.1771)} = 0.8094$.

The direct formula gives $[0.8300 - (0.6200)(0.4000)]/\sqrt{[1-(0.6200)^2][1-(0.4000)^2]} = 0.8094$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.

T06-A01-V08: Task switching and completion after task load

Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = -9.5000$, while $\sum e_X^2 = 28.0000$ and $\sum e_Y^2 = 6.7800$.

Work through the calculation

Thus $r(e_X, e_Y) = -9.5000/\sqrt{28.0000(6.7800)} = -0.6895$.

The direct formula gives $[-0.7617 - (-0.5500)(0.4500)]/\sqrt{[1-(-0.5500)^2][1-(0.4500)^2]} = -0.6895$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.

T06-A01-V09: Discussion posts and reasoning after engagement

Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = 13.2000$, while $\sum e_X^2 = 42.0000$ and $\sum e_Y^2 = 6.6743$.

Work through the calculation

Thus $r(e_X, e_Y) = 13.2000/\sqrt{42.0000(6.6743)} = 0.7884$.

The direct formula gives $[0.8460 - (0.5000)(0.5700)]/\sqrt{[1-(0.5000)^2][1-(0.5700)^2]} = 0.7884$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.

T06-A01-V10: Practice regularity and retention after study time

Set up the calculation

Both residual columns have mean zero apart from displayed rounding.

Their cross-product sum is $\sum e_X e_Y = 9.4000$, while $\sum e_X^2 = 28.0000$ and $\sum e_Y^2 = 6.6686$.

Work through the calculation

Thus $r(e_X, e_Y) = 9.4000/\sqrt{28.0000(6.6686)} = 0.6879$.

The direct formula gives $[0.7637 - (0.5600)(0.4600)]/\sqrt{[1-(0.5600)^2][1-(0.4600)^2]} = 0.6879$.

Small differences can arise if the displayed correlations are rounded before substitution.

Interpret and check the result

Each residual is the part of its focal variable not linearly predicted by Z.

Their correlation describes how those remaining parts move together.

It is still an adjusted association, not automatically a causal effect.