Supplemental Material for:

Progression in Substance Use Initiation: A Multilevel Discordant Monozygotic Twin Design

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Results of Tests for Violations of the Proportional Hazard Assumption Within Baseline Models

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Results of Tests for Violations of the Proportional Hazard Assumption Within Models Controlling for Lifetime Use of the Third Substance

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Censored Co-Twin Deviation in Age of Onset of the Second Substance for Typical and Atypical Sequencing Patterns

Table S1

Results of Tests for Violations of the Proportional Hazard Assumption Within Baseline Models

Typical Sequencing	χ^2	df	*p*-value	Atypical Sequencing	χ^2	df	*p*-value
Tobacco Initiation → Alcohol Initiation (n = 2,558)				Alcohol Initiation → Tobacco Initiation (*n* = 1,722)			
Age	.43	1	.51	Age	.01	1	.91
Sex	.07	1	.80	Sex	.004	1	.95
WTP age of tobacco initiation	.27	1	.61	WTP age of alcohol initiation	.64	1	.42
BTP age of tobacco initiation	77.39	1	<.0001	BTP age of alcohol initiation	.47	1	.49
Tobacco Initiation → Cannabis Initiation (*n* = 2,224)				Cannabis Initiation → Tobacco Initiation (*n* = 338)			
Age	.90	1	.34	Age	.01	1	.91
Sex	.0001	1	.99	Sex	.01	1	.93
WTP age of tobacco initiation	.02	1	.90	**WTP age of cannabis initiation**	9.71	1	.002
BTP age of tobacco initiation	60.38	1	<.0001	**BTP age of cannabis initiation**	92.29	1	<.0001
Alcohol Initiation → Cannabis Initiation (*n* = 2,410)				Cannabis Initiation → Alcohol Initiation (*n* = 552)			
Age	.13	1	.72	Age	.10	1	.75
Sex	.001	1	.98	**Sex**	3.53	1	.06
WTP age of alcohol initiation	.18	1	.67	WTP age of cannabis initiation	.47	1	.49
BTP age of alcohol initiation	6.29	1	.01	**BTP age of cannabis initiation**	108.96	1	<.0001

Notes. WTP = within-twin-pair, BTP = between-twin-pair. Tests for proportional hazard violations were conducted by calculating the interaction between each predictor and the log of the time-to-event variable. To remain conservative in our estimates of violations, an alpha level of .10 was used to determine significance. Bolded parameters indicate significant interactions. To adjust for violations, all significant interactions were entered into the models.

Table S2

Results of Tests for Violations of the Proportional Hazard Assumption Within Models Controlling for Lifetime Use of the Third Substance

Typical Sequencing	χ^2	df	*p*-value	Atypical Sequencing	χ^2	df	*p*-value
Tobacco Initiation → Alcohol Initiation (n = 2,534)				Alcohol Initiation → Tobacco Initiation (*n* = 1,706)			
Age	.24	1	.63	Age	.001	1	.98
Sex	.04	1	.85	Sex	.01	1	.93
WTP age of tobacco initiation	.001	1	.97	WTP age of alcohol initiation	.73	1	.39
BTP age of tobacco initiation	38.73	1	<.0001	BTP age of alcohol initiation	.01	1	.92
WTP lifetime cannabis use	.004	1	.95	WTP lifetime cannabis use	.01	1	.94
BTP lifetime cannabis use	.0001	1	.99	BTP lifetime cannabis use	.001	1	.98
Tobacco Initiation → Cannabis Initiation (*n* = 2,224)				Cannabis Initiation → Tobacco Initiation (*n* = 338)			
Age	.54	1	.46	Age	.01	1	.91
Sex	.0003	1	.99	Sex	.01	1	.93
WTP age of tobacco initiation	.0002	1	.99	**WTP age of cannabis initiation**	9.71	1	.002
BTP age of tobacco initiation	38.02	1	<.0001	**BTP age of cannabis initiation**	92.29	1	<.0001
WTP lifetime alcohol use	.01	1	.94	WTP lifetime alcohol use	--	1	--
BTP lifetime alcohol use	.0003	1	.99	BTP lifetime alcohol use	--	1	--
Alcohol Initiation → Cannabis Initiation (*n* = 2,410)				Cannabis Initiation → Alcohol Initiation (*n* = 552)			
Age	.06	1	.80	Age	.12	1	.73
Sex	.002	1	.96	**Sex**	4.25	1	.04
WTP age of alcohol initiation	.16	1	.69	WTP age of cannabis initiation	.26	1	.61
BTP age of alcohol initiation	2.60	1	.11	**BTP age of cannabis initiation**	96.31	1	<.0001
WTP lifetime tobacco use	.07	1	.80	**WTP lifetime tobacco use**	6.22	1	.01
BTP lifetime tobacco use	.0001	1	.99	**BTP lifetime tobacco use**	7.90	1	.01

Notes. WTP = within-twin-pair, BTP = between-twin-pair. Tests for proportional hazard violations were conducted by calculating the interaction between each predictor and the log of the time-to-event variable. To remain conservative in our estimates of violations, an alpha level of .10 was used to determine significance. Bolded parameters indicate significant interactions. To adjust for violations, all significant interactions were entered into the models. In the model predicting the age of tobacco initiation from the age of cannabis initiation, interactions for within- and between-twin-pair indicators of lifetime alcohol use were not estimated because everyone in the analysis had used alcohol. Sample sizes for typical and atypical sequencing models of the ages of tobacco and alcohol initiation are smaller than for baseline models because some individuals did not report on their lifetime cannabis use.

Table S3

Censored Co-Twin Deviation in Age of Onset of the Second Substance for Typical and Atypical Sequencing Patterns

Typical Sequencing		Atypical Sequencing	
Tobacco Initiation → Alcohol Initiation (*n* = 369)		Alcohol Initiation → Tobacco Initiation (*n* = 474)	
Range (T1 censored)	-7.0 – 14.0	Range (T1 censored)	-7.0 – 19.0
Range (T2 censored)	-8.0 – 14.0	Range (T2 censored)	-7.0 – 17.0
Mean (SD; T1 censored)	1.6 (3.1)	Mean (SD; T1 censored)	3.0 (3.5)
Mean (SD; T2 censored)	1.3 (2.9)	Mean (SD; T2 censored)	2.7 (3.2)
Used earlier (%; T1 censored)	59.3	Used earlier (%; T1 censored)	79.8
Used earlier (%; T2 censored)	60.4	Used earlier (%; T2 censored)	78.3
Tobacco Initiation → Cannabis Initiation (*n* = 54)		Cannabis Initiation → Tobacco Initiation (*n* = 132)	
Range (T1 censored)	-6.0 – 7.0	Range (T1 censored)	-3.0 – 15.0
Range (T2 censored)	-7.0 – 15.0	Range (T2 censored)	-5.0 – 11.0
Mean (SD; T1 censored)	1.0 (2.8)	Mean (SD; T1 censored)	3.1 (3.6)
Mean (SD; T2 censored)	0.3 (3.8)	Mean (SD; T2 censored)	2.5 (3.2)
Used earlier (%; T1 censored)	50.0	Used earlier (%; T1 censored)	78.6
Used earlier (%; T2 censored)	43.3	Used earlier (%; T2 censored)	77.4
Alcohol Initiation → Cannabis Initiation (*n* = 89)		Cannabis Initiation → Alcohol Initiation (*n* = 209)	
Range (T1 censored)	-1.0 – 8.0	Range (T1 censored)	-3.0 – 11.0
Range (T2 censored)	-3.0 – 14.0	Range (T2 censored)	-3.0 – 9.0
Mean (SD; T1 censored)	2.1 (2.0)	Mean (SD; T1 censored)	1.6 (2.2)
Mean (SD; T2 censored)	1.9 (2.9)	Mean (SD; T2 censored)	1.2 (2.2)
Used earlier (%; T1 censored)	78.4	Used earlier (%; T1 censored)	70.6
Used earlier (%; T2 censored)	67.3	Used earlier (%; T2 censored)	57.0

Notes. SD = standard deviation, T1 = twin 1, T2 = twin 2. Sample sizes indicate the number of twins censored due to discordant sequencing. Twins were censored if they used the second substance before the first substance in the requisite sequence. Units for all estimates are in years. Deviations calculated by subtracting the censored twin's age of onset for the second substance from their non-censored co-twin's age of onset. Positive deviation values indicate that the censored twin used the second substance earlier than their non-censored co-twin.